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ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

Number 193 OCTOBER, 1953

1953–1954—Another Big Publication Year

Large Publication Program Outgrowth of Diversified Annual Meeting and High Level of Activity in Technical Committees

The continuing expansion of the Society's publication schedule is evidenced by the number of publications described below which will appear this year and which cover a wide range of materials. In addition to the regular issues—Supplements to the Book of Standards, *Proceedings*, Index to Book of Standards, the Year Book and the special compilations of ASTM standards, a great many symposiums and special publications will begin to flow from the presses out to ASTM's far-flung membership within the next few months.

Regular Publications

Book of Standards Supplements—Index to Standards—1953 Proceedings—Year Book

1953 Supplements to Book of ASTM Standards

The 1953 Supplements to the 1952 Book of Standards will be issued in seven parts in heavy paper covers. They will include all new and revised standards and tentatives adopted or accepted at the Fifty-sixth Annual Meeting or by the Administrative Committee on Standards. Work is now under way on these supplements looking toward their appearance before the close of the year or early in 1954.

1953 Proceedings

The 1953 *Proceedings* (to be issued about January) will once again be a sizable volume, of around 1300 pages. The large size of this volume is to be expected because of the increasing number of technical papers and discussions presented at the Annual Meeting and because of the greater volume of committee reports growing out of the steady expansion of committee work into new fields. The papers and their discussions presented at the Annual Meeting as part of special symposiums will appear separately as special technical publications.

1953 Index to ASTM Standards

This Index continues to increase in value as the number of standards becomes larger, and again it will give the latest reference to publications where the various specifications and test methods appear. This volume is particularly significant in Supplement years in view of the increased number of books involved. Publication of the 1953 edition is scheduled for February and will total some 280 pages.

1953 Year Book

The Year Book, which became available in September, contains a list of the complete membership and official company-member representatives (name, title, address, company, etc.), a list of geographical distribution of members, and personnel of all ASTM committees, as well as other pertinent information. This book is furnished to members on request.

Special Technical Publications

Symposiums—Marburg and Gillett Lectures—Effect of Temperature Report—Bibliographies on Synthetic Detergents and Electrical Contacts—Spectrochemical Analysis Index

THE following symposiums, featured as part of the 1953 Annual Meeting, will be published separately with discussions. Summaries of the various papers comprising these symposiums appeared in the May issue of the ASTM BULLETIN.

1953 Annual Meeting Symposiums:

Effect of Temperature on the Brittle Behavior of Metals with Particular Reference to Low Temperatures
Fluorescent X-Ray Spectrographic Analysis
Radioactivity—Isotopes and Tracer Techniques
Techniques for Electron Metallography
Lateral Pile Load Tests
Porcelain Enamels and Ceramic Coatings as Engineering Materials
Dynamic Testing of Soils

Symposium on Effect of Temperature on the Brittle Behavior of Metals with Particular Reference to Low Temperatures (STP 158)

Despite the existence of a large accumulation of data, technical papers, and reports on low-temperature properties and behavior of metallic materials, sudden, unexpected, and frequently disastrous failures continue to occur in engineering structures and expensive equipment. Very little of the wealth of available information has been fully evaluated and found its way into the commonly used handbooks. Furthermore, it is apparent that there is a lack of general comprehension and application of the knowledge which has been reported by investigators concerning important metallurgical and mechanical variables and their influence on low-temperature ductility and the mechanism of fracture.

Consequently, the Low Temperature

Panel of the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals has sponsored this symposium to bring together and summarize the state of knowledge of the subject, up to the present, in an effort to make designers and materials engineers more fully cognizant of the joint role played by metallurgical and mechanical factors in their influence on the behavior of metals at low temperatures, and particularly of the variable response to variations in stress systems, strain rates, and size effects.

Some idea of the extent of the coverage may be had from the fact that twenty-seven papers were presented during the five sessions. They covered the following broad fields (1) the evaluation of brittle failures in ships and engineering structures, (2) criteria of metal behavior for design engineers, (3) metallurgical and mechanical factors, (4) significance and reliability of notch toughness tests, and (5) certain aspects of current research, including new data on titanium, quenched and tempered steels at high strength levels, and several types of cast irons.

Because of the large number of papers, some of them being quite extensive, no decision has been reached on the exact form of publication. The Joint Committee, through appropriate subcommittees, plans to evaluate the various contributions, having in mind possible condensation and elimination of duplication where feasible, so that a logical recommendation can be made on publication.

Symposium on Fluorescent X-Ray Spectrographic Analysis (STP 157)

Whenever primary X-rays of sufficiently short wavelength are absorbed by matter the characteristic fluorescent X-rays of the elements in the specimen are excited. In recent years improvements in the generation of high-intensity X-ray beams and in the means of detecting and measuring X-rays have made this principle feasible as the basis for a method of quantitative analysis.

As a result of the current interest in fluorescent X-ray spectrographic analysis, Committee E-2 on Emission Spectroscopy sponsored a six-paper symposium on this subject. The papers include one on basic theory and fundamentals; one on general aspects of analytical applications; three papers on specific fields of application of the technique to metallic materials, minerals, and stainless steels; and a paper on multichannel recording in X-ray fluorescent analysis.

In the papers and discussion the consensus appears to be that fluorescent X-ray spectrographic analysis should be regarded as a promising supplement—not as competition—to current analytical methods such as the more common spark and arc methods of emission spectrochemical analysis. X-ray spectrographic analysis has proved particularly successful in the analysis for elements of higher atomic numbers.

It is expected that the complete symposium will be published early next year.

Symposium on Radioactivity—Isotopes and Tracer Techniques

Committee E-10 on Radioactive Isotopes was formed to promote the knowledge of the use of radioactive isotopes in materials testing, to aid and advise other technical committees of the Society interested in their use, and to perform other related appropriate functions in this field. The committee considered that its main objective was to bring to the attention of ASTM members the potential usefulness of radioactive techniques, and that a Symposium on Radioactivity—Isotopes and Tracer Techniques would give the potentialities of radioactivity for testing and measurement.

Although no publication was planned in arranging the symposium, the papers and discussion were so enthusiastically received that an attempt is being made to gather all the material available and print it. The papers comprising this symposium cover properties and uses of radioisotopes, application of radioactive measurements to ASTM work, design of radioisotope laboratories, training personnel in radioisotope techniques, instrumentation, and management problems resulting from radioisotope utilization by industry.

Symposium on Techniques for Electron Metallography (STP 155)

The electron microscope is a powerful tool for the investigation of submicroscopical structure. Its capabilities have been clearly demonstrated in numerous applications to a variety of research problems. In its present state of development, however, it must be used as a transmission microscope. In order to employ this instrument for the study of the structure of opaque materials, such as metallurgical specimens, special techniques are needed. As in the case of optical metallography, the structure is delineated by suitable etching methods. The etched structure is regenerated in an extremely thin "replica," this must be transparent to the electron stream which constitutes the illumination. The replication process is necessarily complex and depends for its success upon critical attention to details of specimen preparation.

The many techniques that have been developed to date are evidence of the ingenuity displayed in striving toward a true representation of structure. None of these, perhaps, meets all of the requirements. Nevertheless, the results show promise of eventual attainment of this goal, within practical limits. The purpose of this symposium is to present examples of techniques in common use, or of potential value, in the hope that increased interest in the application of electron microscopy to metallurgical problems will result.

The eleven papers comprising this symposium were a logical development of results so far obtained as set forth in the various progress reports of Subcommittee XI on Electron Microstructure of Steel of Committee E-4 on Metallography which have been assembled at intervals since 1951. Many techniques have been sought out, used, retained, or discarded in the subcommittee's attempts to best bring out the secrets of the microstructure of steel. Realizing the potential value of a compilation of techniques on preparation, mounting, and washing of metallic specimens the committee organized the present symposium. It is expected that copies of this publication will be available in December.

Symposium on Lateral Pile Load Tests (STP 154)

A problem that often occurs in the design of pile foundations concerns the ability of the piles to resist lateral force applied at the pile heads. For many years engineers have been making field tests on full size piles and laboratory tests on model piles to investigate the behavior of the piles under this type of loading. Very little of these test data has ever been published so that there is almost no literature available on the subject. Furthermore, the tests were performed in many different ways and there is no method of test that even approximates a standard procedure.

This symposium was sponsored by Committee D-18 on Soils for Engineering Purposes for the purpose of making actual test data available to the profession. It is the expectation of the committee that the material presented during the symposium will lead to the development of a standard procedure for making tests of this type.

This symposium, consisting of seven papers, is scheduled for publication in November.

Symposium on Porcelain Enamels and Ceramic Coatings as Engineering Materials (STP 153)

This symposium was set up by Committee C-22 on Porcelain Enamels as a carefully planned and thorough effort to make "working engineers" better acquainted with the very useful and available subject materials.

In the program itself, due attention has been given to a number of important but diversified fields to which such coatings are particularly adapted. These fields cover areas wherein an attractive and easily maintained surface is desired or where metal is subject to deterioration by such things as heat, abrasion, vibration, or close contact with corrosive liquids and gases of many kinds.

It is quite possible that some of the greatest financial savings to be gained by use of ceramic coatings will be made in areas where ordinary uncoated steel is used at moderately high temperatures and has heretofore been frequently replaced as a matter of course.

This extensive and important symposium consisting of 15 papers will be available in November.

Symposium on Dynamic Testing of Soils (STP 156)

The purpose of this symposium is twofold: first, to assemble available information, and second, to discuss as yet unsolved problems in soil dynamics.

From the practicing engineer's point of view the impetus to study these problems is due mainly to increased speeds and loads of our vehicles affecting highway subsoils and also to the practical applications of precompaction of subsoils by means of dynamic methods.

From the more theoretical point of view the determination of basic dynamic soil values, such as moduli of elasticity, damping, spring characteristic, energy dissipation, resonance phenomena, etc., are of fundamental importance.

Both points of view lead to one of the predominant and rather difficult questions: can we develop a mathematical model or dynamic analogy which will permit the prediction of the behavior of soils subjected to vibratory loads?

With these thoughts in mind, twelve papers covering the following were written as the first approach toward a solution of some of the above questions: elasticity and damping of oscillating bodies on the soil, the pressures generated in soil by compacting equipment, loose sands—their compaction by vibroflotation, performance records of engine foundations, makromeritic liquids, pilot studies on solid dynamics, compacting of sand at resonant frequency, the elastic theory of soil dynamics, a dynamic analogy for foundation-soil systems, a discontinuous model for the problems of soil dynamics, vibration research on road construction, and vibrations in semi-infinite solids due to periodic surface loading.

Publication of this material in a symposium volume will be early next year.

Gillett Lecture

The second Gillett Memorial Lecture, entitled "Micrometallurgy" was presented by Jerome Strauss, Vice-President, Vanadium Corporation of America.

Mr. Strauss comments upon the growing number of major effects upon metals and alloys resulting from or associated with minute changes in composition, both additive and the reverse, many of them dealing with quantities of a minor element ever so much smaller than the content of carbon in the steels. This is not the first occasion on which the influence of metals and alloys of small additions of other metals or other elements has been reviewed, but it is believed to be the first devoted entirely to exceedingly small percentages over a very broad range of metallurgical experimentation and practice.

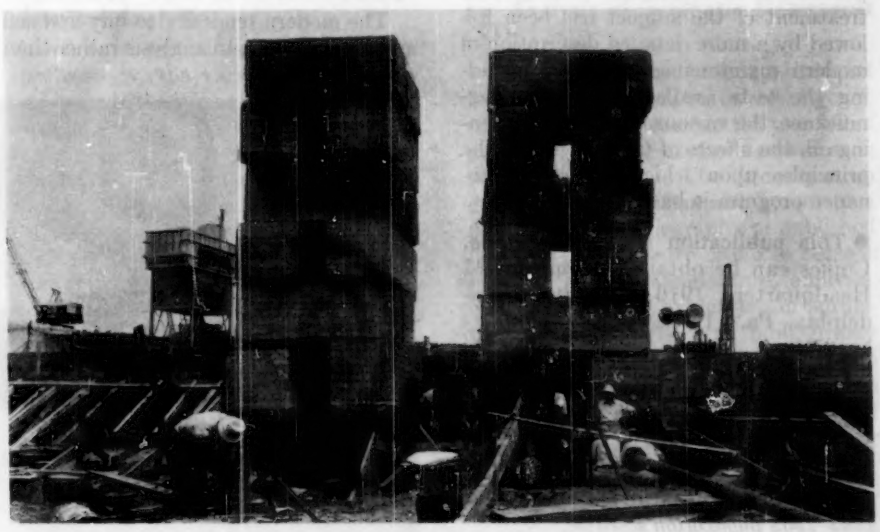
Mr. Strauss's lecture will be published shortly as a separate publication and it will also appear in the *Proceedings*.

Marburg Lecture

The subject of this year's Marburg Lecture, the 27th in a distinguished series, was "An Excursion in Petroleum Chemistry" and was presented by Frederick D. Rossini, Silliman Professor and Head of the Department of Chemistry and Director of the American Petroleum Institute Research Laboratory at the Carnegie Institute of Technology.

Dr. Rossini describes outstanding developments in our knowledge of petroleum and outlines the interesting story of fundamental research in petroleum chemistry as performed in the laboratories of petroleum companies. He discusses projects supported cooperatively by the petroleum industry through the American Petroleum Institute, and in particular will review API Research Projects covering the composition of crude petroleum and the researches conducted to make available to the laboratories of the petroleum industry and to the technical world all of the known data on hydrocarbons and related compounds. This extensive laboratory work involved searching the entire scientific literature, appraising and arranging data in a useful form, and distributing these data both on a national and international scale.

Dr. Rossini's lecture will be published



Test monoliths loaded with 130 tons of concrete were used in the tests described in S. M. Gleser's paper, "Lateral Load Tests on Vertical Fixed-Head and Free-Head Piles," which will appear in the Symposium on Lateral Pile Load Tests.

later this year both as a separate publication and in the *Proceedings*.

Symposium on Insulating Oils—Fifth Series (STP 152)

Over a period of about seven years, Subcommittee IV on Liquid Insulation of ASTM Committee D-9 on Electrical Insulating Materials has held a series of five symposiums on insulating oils. These stemmed from a very active interest in the development of test methods and the evaluation of test results to be used in establishing the serviceability of new and used insulating oils.

The fifth and latest of these symposiums deals with the reclaiming and inhibiting of used insulating oil. This very comprehensive subject is covered by Frank C. Doble in his paper "The Reclamation of Insulating Oils." An extensive discussion on this subject is also included in this publication.

The reclamation of insulating oils, including reconditioning, re-refining, and inhibiting, is of growing importance to power system operators.

Recent developments in a long-studied power system maintenance program have furnished the basis for a new concept of the operating characteristics of insulating oils. The new concept is that insulating oils, when properly serviced, can be given practically unlimited extension of life free from the formation of sludge or excessive acidity due to oxidation even in free breathing transformers.

To develop the subject, discussed briefly are the background, the necessary terminology, and the problems involved and the developments of importance to their solution. This general treatment of the subject has been followed by a more detailed description of modern maintenance methods, including the tests available and their significance, the various means for reclaiming oil, the effects of inhibition, and the principles upon which an oil maintenance program is based.

● **This publication is now available.** Copies can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price, $1.25; to members, $1.

Publication of the following four symposiums presented at the 1952 Annual Meeting was not completed prior to the 1953 Annual Meeting. However, they are now being completed as part of the 1953–1954 publication schedule:

Symposium on Light Microscopy
Symposium on Tin
Symposium on Fretting Corrosion
Symposium on Non-Destructive Testing

Symposium on Light Microscopy (STP 143)

This symposium on light microscopy is broad and far reaching, each of the papers dealing with a specialized application of microscopy. It is introduced by a paper on the methods of microscopy which points out that technical microscopy involves more than apparatus and preparative techniques—it necessitates an extension of reasoning in terms of small-scale structures and processes. Another author describes two trends in apparatus development: first, the use of apparatus to widen the applicability of the microscope as a magnifying instrument; second, apparatus to extend the application of the microscope beyond its original purpose to qualitative and quantitative analysis of optical and other physical properties of small objects. The use of the light microscope in the evaluation of textile material, methods of polarized light microscopy as applied to the study of crystals, application of light microscopy in concrete research, microscopic examination of metallic specimens, microscopy of resins and plastics and particle size are covered in detail by authorities in these various fields. The symposium was sponsored by Committee E-1 on Methods of Testing.

● **This publication is now available.** Copies can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price, $2.50; to members, $1.85.

Symposium on Tin (STP 141)

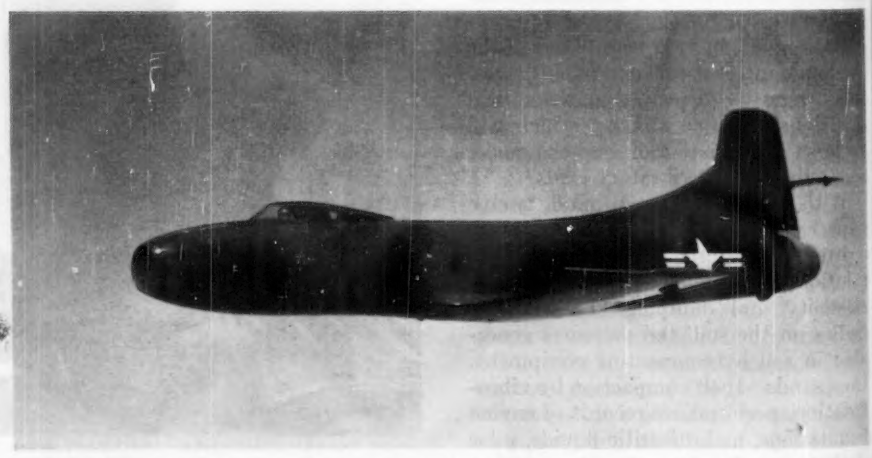
The modern tendency to buy and sell metals according to analysis rather than by brand name has not yet reached tin. In fact, it is the only major common metal not covered by specifications in this country. Now that there is a possibility of a free market for tin, and since about half the tin used in this country is produced (smelted) here, the advocates of a systematic classification for tin according to quality have been greatly encouraged.

Committee B-2 on Non-Ferrous Metals and Alloys has been asked to look into the feasibility and desirability of preparing specifications for this metal. The first step in this direction was the arrangement for a Symposium on Tin to obtain actual information concerning such problems as tin resources, production capabilities, conservation measures, fields of usage, and problems of analyses. Its purpose is to overcome some widespread misunderstandings concerning tin production problems and analytical difficulties, and to give information on some applications of tin and the effects of impurities. Also included in this volume is a panel discussion on methods of analysis.

● **This publication is now available.** Copies can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price, $2.50; to members, $1.85.

Symposium on Fretting Corrosion (STP 144)

The phenomenon of fretting corrosion has been recognized for over two decades, but a partial understanding of its mechanism has been arrived at only in recent years. The investigation of fretting corrosion has necessarily included lubrication studies. Lubricating greases are widely used in antifriction bearings, and Technical Committee G on Lubricating Grease of Committee D-2 on Petroleum Products and Lubricants has a corresponding interest in fretting cor-



To build a jet which is faster than today's, higher burner operating temperatures are required; to attain them, porcelain enameled parts may be the answer—saving critical alloys.

rosion which prompted them to sponsor the symposium. Fretting corrosion has been defined as an oxidation of the mating surfaces of two parts when pressed closely together, as in a press fit or a tight bolted assembly where there is some relatively minute oscillatory motion between the two surfaces. The five papers cover present status of fretting wear, fretting corrosion tendencies of several combinations of materials, fretting corrosion in fitted members, effect of lubricants in minimizing fretting corrosion, and the mechanism of fretting corrosion.

● **This publication is now available.** Copies can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price, $2.75; to members, $2.

Symposium on Non-Destructive Testing (STP 145)

The great interest currently being shown by industry in non-destructive testing resulted in a symposium sponsored by Committee E-7 on Non-Destructive Testing. This symposium augments R. C. McMaster's 1952 Marburg Lecture on "Non-Destructive Testing."

The symposium is of an international nature including as it does papers from seven foreign countries. Various types of non-destructive tests as conducted in Italy, France, Holland, Switzerland, and Germany are presented. In addition, a recent American development of extreme interest is covered in a paper on the development and use of immersed reflectoscopic inspection techniques on aircraft components. The work of Subcommittee II on Radiographic Standards for Steel Welds in Preparing Standard Comparison Radiographs of Steel Welds is also included. This work, which required two years to assemble and classify, is of great immediate interest to the welding industry.

● **This publication is now available.** Copies can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price, $2; to members, $1.50.

Report on the Elevated-Temperature Properties of Chromium-Molybdenum Steels (STP 151)

This is the second in a current series of reports prepared under the auspices of the Data and Publications Panel of the ASME-ASTM Joint Committee on Effect of Temperature on the Properties of Metals. In 1938, the Joint Committee compiled the high-temperature data then available, which was issued as a data book by the Sponsor Societies. It is now out of print. Rather than attempting to bring the former creep volume up to date which would involve considerable delay, the Joint Committee has adopted the policy of conducting intensive surveys on various families of metals, such as stainless steels, chromium molybdenum steels, copper and copper alloys, etc., and will issue these data reports periodically. This has the advantage of making the latest data available as soon as the surveys are completed. The first report of this series covered a number of the commercially produced stainless steels, namely, The 1952 Report on the Elevated-Temperature Properties of Stainless Steels (*STP 124*).

This report is a graphical summary of the elevated-temperature strength data for the chromium-molybdenum steels. It includes summary curves for tensile strength; 0.2 per cent offset yield strength; per cent elongation and reduction of area; stresses for rupture in 100, 1000, 10,000 and 100,000 hr; Larson-Miller parameter curves; and stresses for creep rates of 0.0001 and 0.00001 per cent per hour (1 per cent in 10,000 and 100,000 hr).

The Appendix contains the primary data from which the summary curves were prepared. The data sheets in the Appendix also include the chemical composition, processing data, heat treatment, and other pertinent information about the steels included in this survey.

This report contains summary curves for 23 steels, and the Appendix contains data sheets for 52 steels.

● **This publication is now available.** Copies can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price, $4.75; to ASTM and ASME members, $3.50.

Procedures for Emission Spectrochemical Analysis

Due to recent advances in emission spectroscopy, the variety of apparatus and techniques currently in use has become so large as to preclude standardization to the point that would enable the committee to write tentative methods. It was felt that the best approach to the problem would be the collection of procedures that are currently being used. The committee has collected and prepared for publication some 50 suggested methods for emission spectrochemical analysis, covering a wide range of materials and techniques. The methods plus four tentative methods on emission spectrochemical analysis and a detailed index are included in the book.

● **This publication is now available.** Copies can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price, $4.50; to members, $3.40.

Index to the Literature on Spectrochemical Analysis. Part III. 1946–1950 (STP 41-C)

This is the third part of a series of bibliographical surveys on the literature of spectrochemical analysis. The first part (second edition) was published in 1941 and covered the literature for the years 1920 through 1939, with 1467 references. The second part, published in 1947, included about 1044 references with detailed abstracts to articles appearing 1940 through 1945. In preparing the third part of this series, for the years 1946 through 1950, it was found there was a definite preference among users for the inclusion of abstracts and, accordingly, this practice has been continued. Part III closely resembles Part II in form, with references and abstracts listed chronologically by year and in alphabetical order of the first author's name in each year. A detailed subject index is again provided, and, in addition, an author index is included in the present compilation.

The abstracts in Part III are largely quoted *verbatim* from *Chemical Abstracts*, but occasionally they are abridged or quoted from other publications or specially prepared. The source of the abstract is indicated following the literature reference. Part III contains 1234 references, of which 92 are references omitted from the earlier compilation. Efforts have been made to insure completeness for the years covered, and various abstract journals and original sources have been consulted.

This index is scheduled for publication late this year.

Bibliographical Abstracts of Methods for Analysis of Synthetic Detergents (STP 150)

The growth of the synthetic detergent industry has accelerated in recent years, resulting in an increase in the number of different types of detergents as well as in their complexity. The literature on detergent analysis has also grown to a point where a bibliography of published methods should prove useful to persons engaged in the manufacture, analysis, development, and evaluation of surfactants. Accordingly, this bibliography has been prepared by Rubin Bernstein as Chairman of Subcommittee T-2 on Analysis of Synthetic Detergents of Committee D-12 on Soaps and Other Detergents.

The style of this bibliography follows closely that of "Metal Cleaning Bibliographical Abstracts." The references, which are numbered consecutively, are listed by year and then by author or by

the journal in which the article appeared if anonymous. A number of the abstracts are based on the original article. However, many are re-abstracts from *Chemical Abstracts*. It is hoped to keep these abstracts current.

● **This publication is now available.** Copies can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia, Pa. Price, $1.25.

1952 Supplement to the Bibliography and Abstracts on Electrical Contacts (STP 56-H)

In 1952, the Bibliography and Abstracts on Electrical Contacts was republished. The original printing of January, 1944, and all of the supplements that have been issued since then were included, many duplications were eliminated, and errors corrected. A new supplement now being published becomes the first with respect to the 1952 edition, and it includes all new references collected up to January 1, 1953.

This is the largest supplement in number of references, a fact that indicates a growing interest in the research, development, and engineering problems in this field. It is encouraging to note an increase in basic research on some of the fundamental problems, as well as a considerable increase in the number of publications concerning heavy current interruption and control equipment.

This bibliography will be available in November.

1953 Appendix to ASTM Manual of Engine Test Methods for Rating Fuels

This appendix has been prepared by the Division of Combustion Characteristics, of ASTM Committee D-2 on Petroleum Products and Lubricants. It includes recent changes in the 1952 Manual of Engine Test Methods for Rating Fuels and will be available in January.

Fifth Section of X-Ray Diffraction Data Cards

A fifth section (fourth supplementary set) of X-ray diffraction data cards is now being printed. This set consists of 800 new listings.

The complete card index file of X-ray diffraction data for identification of crystalline materials, prepared by the Joint Committee on Chemical Analysis by X-Ray Diffraction Methods of the ASTM, ASXRED, and the British Institute of Physics, will then consist of an original and four supplementary sets. There will be approximately 2950 cards in the five sets, each card representing a diffraction pattern.

Both plain and Keysort cards are printed. Cards of the Keysort variety have the Keysort coding with holes punched but not notch-coded. Full instructions are furnished with each set of Keysort cards for the necessary coding.

A new cloth bound index, comprising 750 pages is being prepared. It will be furnished to each purchaser of the new set of cards. The new book will contain both a numeric and an alphabetic index.

In cooperation with the Wyandotte Chemicals Corp., the Joint Committee on Chemical Analysis by X-Ray Diffraction Methods has helped to develop IBM index cards to be used in conjunction with the diffraction data card file.

The IBM X-Ray Cards were designed to facilitate the matching of powder data obtained from unknown compounds with identifying data in the file of X-ray diffraction data cards and to provide a means for using a partial knowledge of the chemical nature or physical properties of the unknown to assist in the matching operations for qualitative analysis.

The new set of X-ray data cards and the new Index will be available around December.

Reference Radiographs for Inspection of Aluminum and Magnesium Coatings

THESE reference radiographs, approved for publication by the Society at the Annual Meeting under the ASTM Designation E 98 – 53 T, illustrate various types and degrees of discontinuities occurring in aluminum and magnesium castings. They also include a concise numerical system for designating the discontinuities based on the Tentative Industrial Radiographic Terminology for Use in Radiographic Inspection of Castings and Weldments (ASTM Designation: E 52).

The reference radiographs have been reproduced from the Bureau of Aeronautics Reference Radiographs dated August 1, 1951, through the courtesy of the Navy Department, Bureau of Aeronautics. They were selected from a large number of production radiographs of aircraft castings accumulated over a period of years, and are considered to be highly representative of the discontinuities frequently found in aluminum and magnesium castings. The set consists of 62 negatives covering aluminum castings and 45 negatives covering magnesium castings.

Special Compilations of Standards

Steel Pipe—Glass—Petroleum—Paper—Wood—Rubber—Textiles—Adhesives etc.

THE tabulation given below of special compilations of standards should be viewed as approximate only. There are so many factors affecting these books that it is not possible to give any accurate estimate of size or the date on which they will become available. The size is affected by committee recommendations which may be sumitted to the Administrative Committee on Standards and the date of issue is governed somewhat by editorial considerations and the appearance of the Supplements to the Book of Standards, and also to a great extent by the load our printers are carrying. Those now available are so indicated in the text.

It will be noted from the table that supplements to a few of the widely used compilations are to be issued. These supplements will bring the books up to date, and with the original volumes issued quite recently the supplements seemed the most feasible way of making available the new and revised standards.

Electrodeposited Metallic Coatings

THE third edition of ASTM's "Specifications and Tests for Electrodeposited Metallic Coatings"

Sponsoring Committee	Title	Approximate Number of Pages	Approximate Publication Date
A-1	Steel Piping Materials	400	January
B-4	Electrical Heating, Resistance, and Related Alloys	200	December
B-8	Electrodeposited Metallic Coatings	96	October
C-14	Glass and Glass Products	120	December
D-2	Petroleum Products and Lubricants	854	November
D-3	Gaseous Fuels	172	December
D-6, D-10	Paper and Paper Products and Shipping Containers	380	October
D-7	Wood and Wood Preservatives	350	January
D-11	Rubber and Rubber-Like Materials	716	January
D-13	Textile Materials	680	October
D-14	Adhesives	128	December
D-15	Engine Antifreezes	50	November
Supplements			
D-1	Paint, Varnish, Lacquer and Related Products	80	November
D-4, D-8	Bituminous Materials for Highway Constructions, Waterproofing, and Roofing	16	November

includes 16 standards that cover specifications, methods of test, and recommended practices for the various kinds of electrodeposited coatings.

The compilation is sponsored by Committee B-8, a group that includes in its personnel many outstanding authorities in the fields of production of the coatings and their uses. Everyone connected in any way with electroplating will find the standards in this book of great value.

This publication, of 96 pages in heavy paper cover, can be purchased from ASTM Headquarters for $1.85. The price to members is $1.40.

Paper and Paper Products and Shipping Containers

FOR the first time, ASTM has brought together its standards on paper and paper products and those on shipping containers, and combined them in one compact compilation. It is expected that everyone who is interested in these fields will find it most convenient to have the standards for these related topics combined in one publication.

Committee D-6 on Paper and Paper Products and Committee D-10 on Shipping Containers were the sponsors of this publication. The section on paper is the fifth edition of standards dealing with this field. The section on shipping containers—made up entirely of methods of test, except for one standard on definitions of terms—is published here for the first time in compilation form.

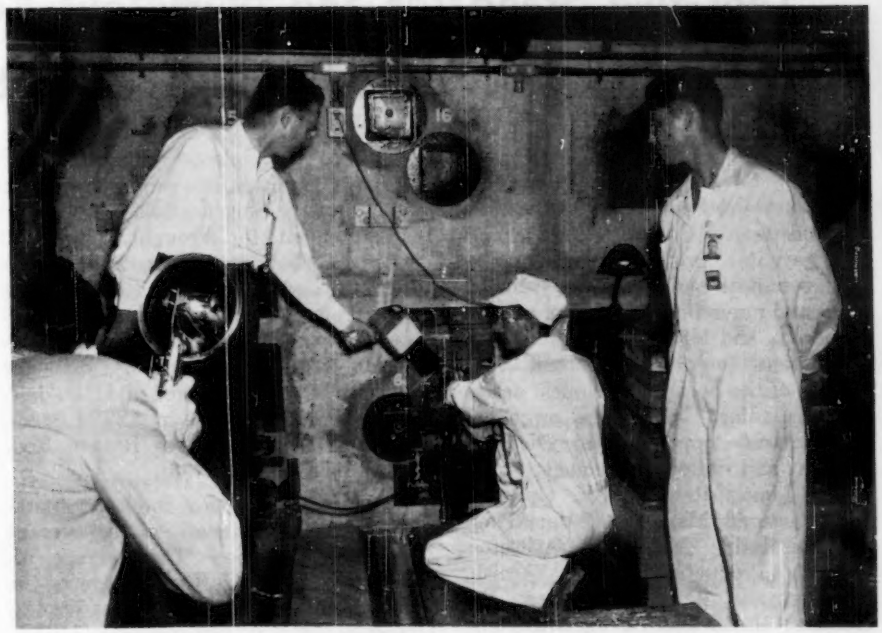
Approximately 115 standards are found in this compact grouping and, in addition, four appendices are included. These are Proposed Methods for Test for Bacteriological Examination of Paper and Paperboard; Smoothness of Paper; Wax Pick Test for Surface Strength of Paper; and Tensile Strength of Paraffin Wax.

This 390-page compilation, in heavy paper binding, is available from ASTM Headquarters for $3.50, with $2.65 as the price to members.

First Supplement—Speed of Testing Bibliography

THE First Supplement to the Partial Bibliography on Effect of Speed of Testing on the Results of Physical Tests of Various Materials will soon be available. Prepared by Subcommittee 2 on Effect of Speed of Testing of ASTM Committee E-1 on Methods of Testing, the Supplement is, like the original publication compiled in stitched, multilith pages.

Titles are listed under six materials classifications: metals, wood, cement and ceramics, organic and fibrous, glass, and general.



Oak Ridge operators removing shielding plugs from the atomic pile before removing isotope stringer. These radioisotopes will be applied to peacetime development—such as materials testing.

Copies of Annual Meeting Papers

CERTAIN of the papers not preprinted for the 1953 Annual Meeting were made available in mimeographed form primarily for the use of those interested in presenting discussion. Some of the members may be interested in securing copies in advance of their appearance in the *Proceedings* or *Special Technical Publications* in which they will be printed. A limited number of copies of some of these papers are still available.

Use of Multichannel Recording in X-Ray Fluorescent Analysis, by M. F. Hasler and J. W. Kemp

The Fluorescent X-Ray Spectrographic Analysis of Minerals, by Howard F. Carl and William J. Campbell

Fundamentals of Fracture in Metallic Materials, by M. Gensamer

Brittle Fracture: Significance for Engineers, by S. L. Hoyt

Interest of the Army in Brittle Failures, by T. T. Paul

Techniques Used in Electron Microscopy of Aluminum Alloys, by M. S. Hunter and F. Keller

Inorganic Replication: Interpretation of Electron Micrographs, by C. J. Calbick

Specimen Polishing Techniques for Electron Metallography of Steel, by W. L. Grube and S. R. Rouze

The Lateral Load Capacity of Timber Pile Groups, by J. O'Halloran

Lateral Load Tests on Piles for Design Information, by A. A. Wagner

A Discontinuous Model for the Problems of Soil Dynamics, by J. J. Slade, Jr.

A Comparison of Impact Testing Machines in the 20–30 ft-lb Range, by R. L. Rickett, W. B. Seens, R. Roeloffs, R. W. Vanderbeck, and C. Daniel

Tension Impact Testing of Sheet Metals, by Carl W. Muhlenbruch

Progress Report of a Sub-Group of Committee B-3, Subcommittee VII on Corrosiveness of Various Atmospheric Test Sites as Measured by Specimens of Steel and of Zinc, by C. P. Larrabee and O. B. Ellis

A Comparison of Methods of Testing for Dissolved Oxygen in Water of High Purity, by Walter L. Riedel

Properties of Various Filtering Media for Atmospheric Dust Sampling, by W. J. Smith and N. F. Suprenant

Investigation of Prot Accelerated Fatigue Test, by E. J. Ward, D. C. Schwartz, and R. T. Schwartz

Elevated Temperature Fatigue Properties of SAE 4340 Steel, by W. J. Trapp and R. T. Schwartz

Prediction of Concrete Durability from Thermal Tests of Aggregate, by E. C. Higginson and D. G. Kretsinger

Significance of Tests on Sulfate Resistance of Concrete, by E. C. Higginson and O. J. Glantz

Evaluation of Curing Compounds for Portland Cement Concrete, by C. E. Proudley

Requests will be filled as long as the supply lasts. A charge of 50 cents will be made to cover handling costs.

Standards Committee Gives Approval to Several New Tentative Standards and Numerous Revisions of Existing Methods and Specifications

MEETING at ASTM Headquarters, September 9, 1953, the Administrative Committee on Standards gave its approval to a large number of new tentative methods and specifications and numerous revisions of existing standards and tentatives. The recommendations come from a broad cross-section of the Society's technical activities, including Committees on Steel; Copper and Copper Alloys; Die Cast Metals and Alloys; Cement; Clay Pipe; Lime; Refractories; Gypsum; Manufactured Masonry Units; Thermal Insulating Materials; Asbestos-Cement Products; Paint, Varnish, Lacquer, and Related Products; Petroleum; Road and Paving Materials; Industrial Water; Plastics; Methods of Testing; Emission Spectroscopy; Filler Metal.

All actions taken by the Administrative Committee on Standards are listed in the accompanying box. The main features of the new and revised standards and specifications are discussed in brief in the following summary.

Steel

Lifting of Government restrictions on molybdenum, June 25, 1953, made it possible for the Steel Committee to recommend withdrawal of Emergency Alternate Provisions pertaining to molybdenum in ten specifications. A complete list of the specifications affected by this action appears in the accompanying box.

[At the request of Committee A-1 on Steel, publication has been withheld of revisions of Tentative Specifications for Alloy Steel Castings for Pressure Containing Parts Suitable for High-Temperature Service (A 217 – 49 T) which had been recommended for approval at the recent Annual Meeting of the Society.]

Copper and Copper Alloys

A general need for a standard specification for die forgings produced by the hot-pressing method resulted in the development by Committee B-5 of Tentative Specifications for Copper and Copper-Alloy Die Forgings (Hot-Pressed) (B 283). The specification covers forging, naval, and leaded naval brass, nickel silver, manganese bronze, aluminum silicon, and high-silicon bronze.

The committee also proposed revision of Tentative Specifications for General Requirements for Wrought Copper and Copper Alloy Rod, Bar, and Shapes (B 249) and for General Requirements for Wrought Seamless Copper and Copper Alloy Pipe and Tube (B 251). Revision of the former provides diameter tolerances for hot-forged rod and bar, such as are applicable in ASTM Specifications for Manganese Bronze Rod, Bar, and Shapes (B 138).

Proposed revision of the latter tentative provides a definition for average diameter of tube—"The average diameter of a tube is the average of the maximum and minimum outside diameters, or of the maximum and minimum inside diameters, as determined at any one cross-section of the tube." Wall thickness tolerances for $\frac{1}{4}$-in. type K copper water tube are revised from 0.0035 to 0.004; and in the section, Straightness Tolerances, reference to applicability of tolerances to ASTM Standard Specification for Seamless Copper Water Tube (B 88) is deleted, such tolerances being inappropriate for this product. This change also made it necessary to delete from Specifications B 88 the reference to the straightness tolerances in B 251.

At the request of the ASME Boiler Code Committee, two standards are tentatively revised to provide yield strength requirements for material used for ASME Boiler Code construction: Standard Specifications for Copper Plates for Locomotive Fireboxes (B 11), and Standard Specifications for Copper Rods for Locomotive Staybolts (B 12). In both standards a note will be added under Section 5, Tensile Properties—"Materials specified to meet requirements of the ASME Boiler Construction Code shall have a minimum yield strength of 10,000 psi at 0.5 per cent extension under load."

In Standard Specifications for Seamless Brass Tube (B 135) the lower load content limit is changed from 0.3 to 0.2 per cent. This change which appears in Table I—Chemical Requirements—for Alloy 3, facilitates manufacture of the alloy in die-scalped tubes for redrawing with a superior finish.

In September, 1952, a tentative revision of Standard Specifications for Manganese Bronze Rod, Bar, and Shapes (B 138) was approved. This tentative revision is now withdrawn and changes made in Section 8 of the Specifications—Dimensions and Tolerances—to clarify requirements for as-hot-rolled, as-extruded, and as-hot-forged rod, bar, and shapes.

In order to carry out as far as possible the general policy of including limits for copper content in copper alloys, Standard Specifications for Copper-Alloy Condenser Tube Plates (B 171) is revised by the addition to Table I—Chemical Requirements—of the requirements for copper content of aluminum bronze alloy E, that is, 78.0 to 85.0. This addition does not offset footnote *b* which also appears there: "Copper plus sum of named elements shall be 99.5 per cent minimum."

Die-Cast Metals and Alloys

Approval was given to the proposal by Committee B-6 to revise and revert to tentative status Standard Specification for Zinc-Base Alloy Die Castings (B 86). This revision increases the permissible maximum copper content of Alloy AG40A from 0.10 to 0.15 per cent. The committee felt that data from tests on Alloy AG40A indicate that increase in copper content does not alter significantly the mechanical properties of the alloy. This change will provide die casters, who employ both alloys AG40A and AG41A, with much needed relief with respect to permissible copper pickup in the lower copper content alloy AG40A.

Cement

Two proposals from Committee C-1 were approved: revisions of Standard Specifications for Masonry Cement (C 91); and Standard Method of Test for Normal Consistency of Hydraulic Cement (C 187). In amending the Specifications the committee endeavored to provide greater uniformity and reproducibility in the mixing of standard test mortars by requiring the use of the new Tentative Method for Mechanical Mixing of Hydraulic Cement Mortars of Plastic Consistency (C 305); and a more duplicable and more permanent perforated dish, together with certain refinements in equipment and procedure for the Water Retention Test.

Actions by the ASTM Committee on Standards, September 9, 1953

New Tentatives

Methods of:

Test for Residual Odor of Lacquer Solvents and Diluents (D 296 – 53 T)
Test for No-Dirt-Retention Time of Traffic Paint (D 1297 – 53 T)
Test for API Gravity of Petroleum and Its Products by Hydrometer (D 287 – 53 T)
Test for Specific Gravity of Petroleum and Its Products by Hydrometer (D 1298 – 53 T)
Test for Shrinkage of Molded and Laminated Thermosetting Plastics at Elevated Temperature (D 1299 – 53 T)
Spectrochemical Analysis of Aluminum and Its Alloys by the Point-to-Plane Spark Technique (E 101 – 53 T)
Test for Chlorine Requirements of Industrial Water and Industrial Waste Water (D 1291 – 53 T)
Test for Odor of Industrial Waste Water (D 1292 – 53 T)
Determination of pH of Industrial Waste Water (D 1293 – 53 T)
Test for Laminated Thermosetting Decorative Sheets (D 1300 – 53 T)

Specifications for:

Copper and Copper-Alloy Die Forgings (Hot-Pressed) (B 283 – 53 T)
Clay Flue Lining (C 513 – 53 T)
Gypsum Concrete (C 317 – 53 T)
Gypsum Formboard (C 318 – 53 T)
ASTM Hydrometers (E 100 – 53 T)

Classification for:

Single- and Double-Screened Ground Refractory Materials (C 316 – 53 T)

Tentative Revisions of Standards

Methods of:

Test for Normal Consistency of Hydraulic Cement (C 187 – 49)
Test for Distillation of Tars and Tar Products (D 20 – 52)
Test for Distillation of Cut-Back Asphaltic Products (D 402 – 49)

Specifications for:

Copper Plates for Locomotive Fireboxes (B 11 – 49)
Copper Rods for Locomotive Staybolts (B 12 – 52)
Seamless Copper Water Tube (B 88 – 51)
Seamless Brass Tube (B 135 – 52)
Manganese Bronze Rod, Bar, and Shapes (B 138 – 52)
Copper-Alloy Condenser Tube Plates (B 171 – 52)
Masonry Cement (C 91 – 51)
Structural Clay Load-Bearing Wall Tile (C 34 – 52)
ASTM Thermometers (E 1 – 53)

Definitions of:

Terms Relating to Thermal Insulating Materials (C 168 – 51)
Terms Relating to Materials for Roads and Pavements (D 8 – 52)

Modification of Tentative Revision of Standards

Specifications for:

Hydraulic Hydrated Lime for Structural Purposes (C 141 – 42)

Revisions of Tentatives

Methods of:

Chemical Analysis of White Pigments (D 34 – 51 T)
Spectrochemical Analysis of Zinc-Alloy Die Castings for Minor Constituents and Impurities (E 27 – 43 T)

Specifications for:

General Requirements for Wrought Copper and Copper-Alloy Rod, Bar, and Shapes (B 249 – 53 T)
General Requirements for Wrought Seamless Copper and Copper-Alloy Pipe and Tube (B 251 – 53 T)
Extra Strength Clay Pipe (C 200 – 50 T)
Inorganic Aggregates for Use in Interior Plaster (C 35 – 53 T)
Asbestos-Cement Corrugated Sheets (C 221 – 53 T)
Asbestos-Cement Roofing Shingles (C 222 – 53 T)
Asbestos-Cement Siding Shingles and Clapboards (C 223 – 53 T)
Asbestos-Cement Pressure Pipe (C 296 – 53 T)
Gasoline (D 439 – 53 T)

Withdrawal of Tentative

Methods of:

Spectrochemical Analysis of Zinc for Lead, Iron, and Cadmium (E 26 – 43 T)

Withdrawal of Standards

Specifications for:

Quicklime and Hydrated Lime for Use in the Textile Industry (C 48 – 24)
Silver Solders (B 73 – 29)

Revision of Standards and Reversion to Tentative

Specifications for:

Zinc-Base Alloy Die Castings (B 86 – 52)

Withdrawal of Emergency Alternate Provisions for Molybdenum

Specifications for:

Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service (A 182 – 52*a* T)
Alloy-Steel Castings for Pressure Containing Parts Suitable for High-Temperature Service (A 217 – 49 T)
Seamless Ferritic Alloy Steel Pipe for High-Temperature Service (A 335 – 52*a* T)
Ferritic Steel Castings for Pressure Containing Parts Suitable for Low-Temperature Service (A 352 – 52 T)
Seamless Low-Carbon and Carbon-Molybdenum Steel Still Tubes for Refinery Service (A 161 – 52 T)
Seamless Cold-Drawn Intermediate Alloy-Steel Heat-Exchanger and Condenser Tubes (A 199 – 52 T)
Seamless Intermediate Alloy-Steel Still Tubes for Refinery Service (A 200 – 52 T)
Seamless Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes (A 209 – 51 T)
Seamless Alloy Steel Boiler, Superheater, and Heat Exchanger Tubes (A 213 – 52 T)
Electric-Resistance-Welded Carbon-Molybdenum Alloy-Steel Boiler and Superheater Tubes (A 250 – 51 T)

Tentative revision of Standard Method of Test for Normal Consistency of Hydraulic Cement (C 187) brings the wording of the text in line with actual practice of a number of years. In Paragraph 4(*c*) of Procedure "± 1 mm" is added to make the sentence read: "The paste shall be of a normal consistency when the rod settles to a point 10 ± 1 mm below the original surface in 30 sec after being released."

Clay Pipe

Tentative Specifications for Clay Flue Lining were developed by Committee C-4 which was assigned the task by the ASTM Board of Directors. The need for such specifications had long been recognized but no group or agency had felt responsible for undertaking their preparation.

These specifications cover clay flue lining intended for use in lining masonry chimneys for their entire height. Flue lining manufactured according to these specifications shall be known as round, oval, rectangular nonmodular, or rectangular modular and shall be made of fireclay, shale, or mixtures thereof and other heat-resistant refractory materials that can conform to the specifications.

Consumer demand for clay pipe in 27 and 33-in. size led Committee C-4 to propose inclusion of this size pipe in Tentative Specifications for Extra Strength Clay Pipe (C 200) inasmuch as the two sizes are manufactured in standard strength. These specifications, which cover clay pipe intended to be used for sewage, industrial waste, and storm water, required changes in Table I—Crushing Strength Requirements—and in Table II—Dimensions—to include the two additional sizes and pertinent data.

Lime

In March, 1951, a tentative revision of Standard Specifications for Hydraulic Hydrated Lime for Structural Purposes was accepted by the Society and published for the purpose of eliciting criticism for consideration before the revision should be incorporated in the standard. Committee C-7 felt it desirable to recommend a change in this revision to include an autoclave test for

soundness since such tests have been developed for other competitive mortar materials such as masonry cement and portland cement.

Committee C-7 also recommended withdrawal of the Standard Specifications for Quicklime and Hydrated Lime for Use in the Textile Industry (C 48). In view of the fact that so little lime is used by the textile industry it was felt unnecessary to have specifications covering that particular use of the material.

Submitted jointly by the Lime Committee and by Committee C-11 on Gypsum was a revision of Tentative Specifications for Inorganic Aggregates for Use in Interior Plaster (C 35) intended to improve the quality of the product when proposed for use with gypsum plaster. The changes appear under Grading, Section 3(*a*), Sieve Analysis, where maximum and minimum percentages have been altered with respect to perlite and sand.

Refractories

Approval was given to a Tentative Classification for Single and Double-Screened Ground Refractory Materials (C 316) which was developed by Committee C-8 in order to avoid misunderstanding and confusion between the purchaser and supplier of these materials by standardizing the terminology and sieves to be used. The classification, which deals only with screening, pertains to ground refractory materials such as bauxite, calcite, chrome ore, clays, diaspore, ganister, grog, kyanite, magnesite, and mullite.

Gypsum

Two new and related specifications, prepared by Committee C-11, represent the first effort of any group to provide recognized specifications for these products: Gypsum Concrete (C 317) and Gypsum Formboard (C 318).

The first named specification covers mill-mixed gypsum concrete which requires the addition of water only at the job. Intended for use in the construction of poured-in-place roof decks or slabs, the specification deals with two types: Type I consists of calcined gypsum and wood chips or shavings; and Type II, calcined gypsum and mineral aggregate.

The second specification covers gypsum formboard for poured-in-place reinforced gypsum concrete roof decks. This formboard consists of an incombustible core, essentially gypsum, with or without fiber, but not exceeding 15 per cent fiber by weight, and surfaced with sheets of fibrous material. The exposed surface is treated specifically to resist fungus growth.

Manufactured Masonry Units

Tentative Revision of Standard Specifications for Structural Clay Load-Bearing Wall Tile (C 34) was recommended by Committee C-15 in order to include single cell, 6-in. nominal thickness tile. These units are produced and used where fire resistive requirements are not important and, since they meet all the physical property requirements for load-bearing and nonload-bearing tile and, generally, can be supplied at less cost to the purchaser, the committee felt they should not be prohibited in this standard.

Thermal Insulating Materials

Standard Definitions of Terms Relating to Thermal Insulating Materials (C 168) is expanded on recommendation of Committee C-16 to include definitions of (*a*) rate of water vapor transmission, (*b*) water vapor permeance, and (*c*) water vapor permeability. Lack of uniformity in terminology and units found in the industry and in ASTM committees prompted C-16 to make an effort to establish uniformity of units pertaining to these properties.

Asbestos-Cement Products

Four recommendations were made by Committee C-17, three of which represent similar revisions in Tentative Specifications for Asbestos-Cement Corrugated Sheets (C 221); Tentative Specifications for Asbestos-Cement Roofing Shingles (C 222); and Tentative Specifications for Asbestos-Cement Siding Shingles and Clapboards (C 223). In each of these, provision is made for dry testing with proper correction of values; statements of Significance of Tests have been added; and minor editorial changes and corrections have been made.

In Tentative Specifications for Asbestos-Cement Pressure Pipe (C 296) a section on Significance of Tests has been added to explain the meanings of the hydrostatic proof test, flexure proof test, and crushing test which are included in the specifications.

Paint, Varnish, Lacquer, and Related Products

Committee D-1 has prepared a Tentative Method of Test for Residual Odor of Lacquer Solvents and Diluents (D 1296) which is a revision of the Test for Residual Odor, Section 7, of Standard Methods of Sampling and Testing Lacquer Solvents and Diluents (D 1268) and will be issued as a separate tentative method. It describes procedures for observation of residual odors of volatile organic chemicals used as lacquer solvents and diluents.

Also prepared as a companion test to Standard Methods of Test for No-Pick-Up Time of Traffic Paint (D 711) is a new Tentative Method of Test for No-Dirt-Retention Time of Traffic Paint (D 1297). This laboratory test method, needed by manufacturers and users of traffic paints, determines the length of drying time after application of traffic paint for the film to show no dirt retention from the track of an automobile tire.

An extensive revision of Tentative Methods of Chemical Analysis of White Pigments (D 34) was undertaken by the committee to meet the need of the paint industry for improved methods for chemical analysis of basic carbonate white lead and basic sulfate white lead to replace the inadequate and obsolete methods now included as Sections 6 to 18.

Petroleum Products and Lubricants

The ASTM Standard Method of Test for Gravity of Petroleum and Its Products by Hydrometer (D 287) is a combination method containing procedures for using both API and specific gravities. Since most foreign countries use specific gravity and would not accept an ASTM gravity method that contained both procedures as an international standard, Committee D-2 recommended separation of the specific gravity method from D 287. This separation will help promote the acceptance of ASTM methods as the basis of international standards. Specification D 287 – 53 T will be titled Tentative Method of Test for API Gravity of Petroleum and Its Products by Hydrometer; Specification D 1298 – 53 T will be titled Tentative Method of Test for Specific Gravity of Petroleum and Its Products by Hydrometer.

Approval was also given to the committee's recommendation to revise Tentative Specifications for Gasoline (D 439) with respect to the minimum octane number requirement of premium-grade gasoline. These minimum octane requirements are reviewed regularly by Technical Committee A on Gasoline and compared with the octane number levels of regular and premium gasolines reported in the latest Summer or Winter National Motor Gasoline Survey. The 1952–1953 Winter Survey reveals a change in octane number level from 85 to 86, and this specification is accordingly revised to reflect this change.

Road and Paving Materials

Three tentative revisions of existing standards recommended by Committee D-4 were approved:

To Definitions of Terms Relating to Materials for Roads and Pavements (D 8) were added the definitions of

"blast furnace slag" which appear in Definitions of Terms Relating to Concrete and Concrete Aggregates (C 125), and withdrawal of the definition of slag; revised definitions of asphalt and pitches in which these materials are specified as residua; and substitution for the June, 1951, tentative revision of the definition of "tars," an improved definition of "tar."

Revisions of Standard Method of Test for Distillation of Tars and Tar Products (D 20) and Standard Method of Test for Distillation of Cut-Back Asphaltic Products (D 402) improves their wording and removes statements relative to supplementary tests, distillate fractions, and distillation residue improperly included as requirements of the distillation method.

In addition in Standard Method D 402, dimensional requirements of Section 3 (*b*) involving the adapter are modified to specify the apparatus more definitely. Several editorial changes are also included in this revision.

Industrial Water

Three new tentative methods, on the recommendation of Committee D-19, were approved as follows:

Tentative Method of Test for Chlorine Requirements of Industrial Water and Industrial Waste Water (D 1291) describes a procedure for determining the quantity of chlorine required to obtain a specific objective in the treatment by chlorination of industrial water including industrial waste water. The method can be applied to all types of industrial water including solutions of individual concentrated industrial wastes and the combined waste water effluents from a plant.

Tentative Method of Test for Odor of Industrial Waste Water (D 1292) is intended to provide a satisfactory, reproducible procedure for determining the threshold odor number of industrial waste water, and to provide a system for classification of odors.

Tentative Method for Determination of pH of Industrial Waste Water (D 1293) covers the procedure for the electrometric measurement of pH values by means of the glass electrode and is intended for control and routine testing.

Plastics

Committee D-20, responding to industrial needs, prepared two new tentative methods:

Tentative Specifications and Methods of Test for Laminated Thermosetting Decorative Sheets (D 1300) applies to sheets consisting essentially of layers of fibrous sheet materials impregnated with thermosetting condensation resins and consolidated under heat and pressure, which can be used for counter and table tops, panelling, baseboards, etc.

Tentative Method of Test for Shrinkage of Molded and Laminated Thermosetting Plastics at Elevated Temperatures (D 1299) provides a method for classifying plastics with respect to shrinkage at temperatures up to 230 C on a relative basis, but is not designed to predict the behavior of materials in service.

Methods of Testing

At the request of Committee D-2 on Petroleum Products and Lubricants, Committee E-1 recommended approval of Tentative Specifications for ASTM Hydrometers (E 100). These specifications cover hydrometers used in testing soils and API hydrometers and thermohydrometers used in testing petroleum products. These instruments are needed in the new tentative test methods for gravity, prepared by Committee D-2 and described above.

Committee D-15 on Engine Antifreezes asked that specifications be prepared providing detailed purchase specifications for two thermometers to be used in Tentative Method of Test for Freezing Point of Aqueous Engine Antifreeze Solution (D 1177). The thermometer specifications are added as a tentative revision of Standard Specifications for ASTM Thermometers (E1).

Emission Spectroscopy

Tentative Method of Spectrochemical Analysis of Aluminum and Its Alloys by the Point-to-Plane Spark Technique is recognized by Committee E-2 as representing an important contribution toward standardization in the field of emission spectroscopy. This method, extensively employed for the spectrographic analysis of aluminum, is designed primarily for the analysis of chill-cast disks but is applicable to any type of sample on which a flat surface suitable for sparking can be machined.

The committee also recommended a revision of Tentative Method of Spectrochemical Analysis of Zinc-Alloy Die Castings for Minor Constituents and Impurities (E 27) to bring it into line with current practice for analysis of this type.

Filler Metal

Recommendation from the AWS-ASTM Joint Committee provides for withdrawal of Standard Specifications for Silver Solders (B 73) which were rendered unnecessary when approval was given by the Standards Committee in September, 1952, to Tentative Specifications for Brazing Filler Metal which covers silver solders.

Technical Papers Published

IT IS planned to include in each issue of the ASTM BULLETIN a list of the technical papers which have recently appeared.

These lists largely comprise papers contained in the newer Special Technical Publications although some of them are advance printing of individual papers that are to appear in the *Proceedings*.

Symposium on Chemical Analysis of Inorganic Solids by Mass Spectrometer

The Mass Spectrometer as a Tool for the Determination of Trace Element Impurities in Solid Samples—Mark G. Inghram.

Mass Spectrometric Analysis of Solids with the High-Frequency Spark—J. A. Hipple and J. G. Gorman

Mass Spectrometric Analysis of Copper for Cuprous-Oxide Rectifiers—W. M. Hickam

Symposium on Fretting Corrosion

Introduction—T. E. De Villiers

The Current Status of Fretting Corrosion—W. E. Campbell

Fretting Corrosion Tendencies of Several Combinations of Materials—J. R. McDowell

Influence of Fretting Corrosion on the Fatigue Strength of Fitted Members—O. J. Horger

Effect of Lubricants in Minimizing Fretting Corrosion—E. W. Herbek, Jr., and R. F. Strohecker

Test Equipment for Evaluating Fretting Corrosion—H. H. Uhlig, W. D. Tierney, and A. McClellan.

Offers of Papers for 1954

THE Administrative Committee on Papers and Publications will meet in early February to consider the papers to be published by the Society in 1954 and to develop the program for the Annual Meeting to be held in Chicago, Ill., June 14 to 18.

All those who wish to offer papers for presentation at the meeting and publication by the Society should send these offers to Headquarters *not later than January 15, 1954*. All offers should be accompanied by a summary which will make clear the intended scope of the paper and will indicate features of the work that will, in the author's opinion, justify its publication and inclusion in the Annual Meeting program.

Suitable blanks for use in transmitting this information will be sent promptly upon request to Headquarters.

ASTM Bulletin

OCTOBER 1953

NO. 193

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

Concerning Letters to the Editor

You may have noticed that in the last two issues of the BULLETIN your President has written a brief message in this column. I am not sure that this is the best utilization of this space. Periodic comments, composed by one person under the compulsion of a deadline, are apt to degenerate into stereotyped, uninteresting platitudes.

I have always read with interest in technical publications and the daily press those columns dedicated to "Letters to the Editor," "Opinion," or "Comment." Spontaneously, the authors of these feel very strongly about something and express it in an uninhibited fashion. While occasionally ASTM Headquarters receives a few letters, yet neither the number of these nor the subject matter has justified a page in each issue of the BULLETIN for their publication.

I am sure that once a month some of our 7500 members have something worth while they would like to say. Fruitful subjects might be: new fields of endeavor for ASTM; constructive criticism of how the Society is run; suggestions for improvement in meetings and publications; controversies about methods of test and specifications not appropriately dealt with in technical committees; and comments on broad trends or happenings in the fields of our work. Such a column might also afford members an opportunity to "stake out a claim" in some field of scientific work pending completion of a more formal presentation.

You will appreciate that the opinions expressed will be those of the writers and not the Society and that anonymous communications will be unacceptable, although publication of an author's name might be withheld on special request.

Taken seriously, I am sure a lot of good can come from this. Your ASTM Staff, Officers, and Directors value and need the opinions and comments of its members. It is only reasonable that 7500 members in all kinds of professions will have a lot more ideas than those few who have the responsibility for ASTM policy. May I urge that if you feel strongly about some worth-while subject, you write a "Letter to the Editor" of the BULLETIN. You can judge how successful the response to this appeal has been by reading this page in the next few issues.

L. B. Sumner Jr.

President, ASTM

1954 Nominating Committee Appointed

Members	Respective Alternates
H. C. Larson, Metallurgical Engineer, Bethlehem Steel Co., Inc.	H. H. Smith, Asst. Manager, Metallurgical Dept., American Steel & Wire Div., United States Steel Co.
R. W. Seniff, Engineer of Tests, Operation and Maintenance Dept., The Baltimore and Ohio Railroad Co.	W. F. Collins, Asst. Chief, Engineering Services, New York Central System.
T. P. Dresser, Jr., Chief Engineer, Abbot A. Hanks, Inc.	W. C. Hanna, Vice-President in Charge of Technical Development, California Portland Cement Co.
W. D. Appel, Chief, Textile Section, National Bureau of Standards.	Herbert Insley, Chief, Div. of Mineral Products, National Bureau of Standards.
A. W. Carpenter, Manager of Testing Labs., The B. F. Goodrich Co.	Simon Collier, Director of Quality, Johns-Manville Corp.
R. C. Alden, Chairman, Research Planning Board, Phillips Petroleum Co.	A. E. Miller, Assistant to Vice-President and Process Chemist, Sinclair Refining Co.

IN ACCORDANCE with the By-laws providing that the Board of Directors shall select a nominating committee for officers, the Board has considered the report of the tellers—D. I. Finch and A. H. Kidder—on the recommendation of members for appointees on the nominating committee and alternates, and has appointed those shown in the table.

Serving on the 1954 Nominating Committee as *ex officio* members are the three immediate past-presidents: L. J. Markwardt, T. S. Fuller, and H. L. Maxwell. The committee will meet sometime in March and will nominate for each office—president, vice-president, and five members of the Board of Directors. The selection by the Nominating Committee will be announced to the members in the ASTM BULLETIN prior to transmission of the official ballots.

Chicago Annual Meeting Takes Shape; Committee Formed

Hotels Reserve Space for June Gathering

With the recent appointment of Dr. A. Allan Bates as chairman of the General Arrangements Committee, Operation Chicago—1954 has started to roll. It is gathering momentum and its result will be the Society's 57th Annual Meeting, complete with the 9th Technical Photographic Exhibit and 11th Apparatus Exhibit.

The Chicago District Council is confident in the recommendation of its officers (Chairman J. E. Ott, Acme Steel Co.; Vice-Chairman W. L. Bowler, Pure Oil Co.) of Dr. Bates for appointment to this important post by ASTM President L. C. Beard. Dr. Bates, who is vice-president of the Portland Cement Assn., is well known in our Society. Long an active member, he has contributed much from the metals field as well as from the cement field. His personality and technical background are such that he has been frequently in demand as a speaker for ASTM District Meetings and for meetings of other groups, especially the American Society for Metals.

At an organizational meeting of the General Arrangements Committee, attended by ASTM's Executive Secretary, R. J. Painter, and called by Dr. Bates in Chicago, September 17, the Annual Meeting and the work of Operating Subcommittees of the General Committee were outlined.

An announcement is expected soon that will place chairmanships of the subcommittees in the hands of active and experienced members who have been concerned with ASTM work in the Chicago District.

Large blocks of sleeping rooms are being set aside at both the Hotels Sherman and Morrison. Much refurbishing and modernization has been going on in both hotels, particularly installation of air-conditioning equipment. All public space, including lobbies, committee rooms, registration areas, and exhibit halls (at the Sherman) are air conditioned. The Apparatus Exhibit will be held on the Mezzanine Floor of the Sherman adjacent to the main registration desk. Chicago is considered an excellent exhibit location and apparatus manufacturers are being solicited.

Among the technical features of the meeting are the following symposiums: Permeability of Soils; Effect of Cyclic Heating; Relation of Test Standards to Building Codes and Performance Standards; Odor; Coal Sampling. Tentatively scheduled also are Tension Testing of Nonmetallic Sheet Materials and Impact Testing.

Officers and members of the Chicago District Council who will form the nucleus for the General Committee on Arrangements for the 1954 Annual Meeting. Seated, *from left to right:* W. L. Bowler, Pure Oil Co., District Vice-Chairman and Chairman, Finance Committee; A. Allan Bates, Vice-President, Portland Cement Assn., Chairman, General Committee on Arrangements; John E. Ott, Vice-President, Acme Steel Co., Chairman, Chicago District; George E. Stryker, Bell & Howell Co., Treasurer, General Committee; R. J. Painter, ASTM Executive Secretary. Standing, *left to right:* John G. Heiland, Bell & Howell Co., Chairman, Photographic Committee; L. S. Marsh, retired, formerly Head, Metallurgy and Inspection, Inland Steel Co.; R. F. Main, Chief Metallurgist, Acme Steel Co.; Major J. de N. Macomb; J. J. Kanter, Directing Engineer, Crane Co., former District Chairman and Chairman of Technical Program Committee; Carl W. Muhlenbruch, Northwestern Technological Institute, Chairman, Promotion and Publicity; J. F. Calef, Chief Chemist, Automatic Electric Co., Chairman, General Information Committee; H. M. Sullivan, Vice-President, Central Scientific Co., Vice-Chairman, Entertainment Committee; B. J. Barmack, Commonwealth Edison Co.; Harry C. Delzell, Executive Director, Concrete Reinforcing Steel Institute, Chairman, Entertainment Committee.

Photographers *Attention!*

9th ASTM Exhibit, June 14–18, 1954, Chicago

One of the very interesting features of the 1954 Annual Meeting to be held at the Hotel Sherman in Chicago will be the 9th Technical Photographic Exhibit and competition. These have featured recent Annual Meetings held in even numbered years. A local photographic committee headed by John G. Heiland, Bell and Howell Co., in cooperation with representatives of Committee E-4 on Metallography, which again is in charge of an enlarged section on photomicrography, will send to the entire membership and all committee members of the Society an entry blank. This will go in the mails this Fall.

In general the theme of the Photographic Exhibit will be, as in the past, Materials, Testing, and Research. Photographs will be invited involving testing instruments, standards, unique uses of materials, etc.

Committee E-4 is planning to expand the already notable section on photomicrography, and letters have been addressed to all members in foreign countries with an excellent response. There will be again a student competition with prizes offered.

Full details will be given in the photographic form and entry blank. The photographic committee is anxious that those interested shall have early advice in order that they can begin planning their entries.

All Items on Standards Ballot Approved

The canvass of the results of the 1953 letter ballot shows that the membership of the Society has approved all the items listed on the ballot. This included 53 revisions of existing standards, and 62 adoptions of tentatives as standards.

Details concerning these actions were given in the Summary of Proceedings of the Fifty-sixth Annual Meeting, which was mailed to all members in September, together with the letter ballots.

Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and locations of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

DATE	GROUP	PLACE
Oct. 26–28	Committee C-16 on Thermal Insulating Materials	Williamsburg, Va. (Williamsburg Inn)
Oct. 27	Joint Pittsburgh District-Society of Automotive Engineers Meeting	Pittsburgh, Pa. (Mellon Institute)
Oct. 27–28	Committee C-22 on Porcelain Enamel	Middletown, Ohio
Nov. 6	Ohio Valley District—Joint Meeting with American Society of Lubrication Engineers	Indianapolis, Ind.
Nov. 12	Northern California District—Joint Meeting with American Chemical Society and American Institute of Chemical Engineers	Berkeley, Calif.
Nov. 13	Southern California District—Joint Meeting with American Chemical Society	Los Angeles, Calif. (Rodger Young Auditorium)
Nov. 17	Committee E-11 on Quality Control of Materials	Philadelphia, Pa. (ASTM Headquarters)
Nov. 18	New York District—Joint Meeting with American Society of Lubrication Engineers	New York, N. Y. (Auditorium of Consolidated Edison Co.)
Nov. 20	Southwest District—Joint Meeting with American Institute of Chemical Engineers, American Chemical Society, and American Society for Quality Control	Houston, Tex.
Dec. 8–9	Committee C-20 on Acoustical Material	Philadelphia, Pa. (ASTM Headquarters)
Dec.	New York District—Joint Meeting with American Institute of Electrical Engineers	New York, N. Y. (Auditorium of Consolidated Edison Co.)
	1954	
Feb. 1–5	**ASTM Spring Meeting**	Washington, D. C. (Shoreham Hotel)
June 13–18	**ASTM Annual Meeting**	Chicago, Ill. (Sherman & Morrison Hotels)

Bulow, Corrosion Metallurgist, Addresses Philadelphia Meeting

A SIZABLE group of 125 members and guests turned out for the first joint meeting in the Philadelphia Area sponsored by the American Society for Testing Materials and the National Association of Corrosion Engineers at Philadelphia's Franklin Institute on September 18, 1953. The technical session, which followed dinner, featured the interesting talk on "Copper and Copper Alloys" presented by C. L. Bulow, Corrosion Metallurgist, Bridgeport Brass Co.

Based on his years of experience as a research chemist and later as a corrosion metallurgist, Mr. Bulow discussed copper from the standpoint of corrosion resistance, physical and mechanical properties, and fabrication properties, emphasizing the corrosion resistance of these materials under a variety of conditions. The influence of factors such as alloy composition, corrosive media, temperature, stress, corrosion inhibitors, and cleanliness and so forth was brought out.

Mr. Bulow, in addition to his activities on ASTM Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys and NACE Technical Practices Committee TP-5 on Corrosion Problems Involved in Processing and Handling Chemicals, is a member of the American Chemical Society, Electrochemical Society, Non-Ferrous Subcommittee of ASME Boiler Code Committee, American Petroleum Institute, and Institute of Metals.

Guests at the meeting included two of the Warwick Memorial Award recipients at the University of Pennsylvania for 1953, George Herman and Victor Sweet, both of whom are Seniors, majoring in Metallurgical Engineering and Civil Engineering, respectively.

Fred F. Van Atta Joins ASTM Staff as Special Assistant

WE ARE pleased to announce the appointment of Fred F. Van Atta to the ASTM Staff as Special Assistant. Recently Manager, Building Div., Carolinas Branch Associated General Contractors, he was formerly acting Secretary-Treasurer of the American Concrete Institute and Editor of the *ACI Journal*.

For some time it has been hoped to build up Staff personnel, and particularly with someone experienced in technical society or trade association activities. Mr. Van Atta's experience combines both of these and, further, from his experience with the ACI he has a good working knowledge of ASTM and in fact many of the men with whom he has been associated are active members and officers of the Society.

He will report directly to the Executive Secretary. For the immediate future his activities will involve largely the coordination and extension of our developmental and promotional activities, involving sales promotion, membership, advertising and exhibit, and the developmental phases of other ASTM operations. Various special assignments will be made from time to time. Much of this work was formerly handled in the office of the Assistant Secretary.

A graduate of Michigan State College in 1934 with a degree of Bachelor of Science in Civil Engineering, with honors, he served in the U. S. Coast and Geodetic Survey, was with the Tennessee Valley Authority for several years, and was later in the Los Angeles District, Corps of Engineers. From October, 1941, to December, 1945, he had a variety of experience with the Army Engineers, including service in the Philippines.

He was for over six years with the ACI, succeeding Harvey Whipple as Secretary-Treasurer. Then for a year he was with the Associated General Contractors, where he was concerned with a variety of problems including labor activities, industrial safety, apprentice training, and such programs.

Fred F. Van Atta

He reported to ASTM Headquarters officially on September 16. Mrs. Van Atta and their two children, Don, 15, and Janet, 9, are getting settled in their home at 604 Meeting House Road, Jenkintown, Pa.

1954 Award of Merit Committee

WITH the acceptance of David Scott, Jr., and C. R. Stock, the personnel of the 1954 Award of Merit Committee is completed. These two men will serve with hold-over members, A. T. Goldbeck (as Chairman) and H. W. Stuart. H. L. Maxwell will represent the Board of Directors on this committee. Page 632 of the current Year Book gives the rules (recently revised) governing the Award of Merit in which the ASTM technical committees have an important part.

ASA Standards on Oxychloride Flooring

A GROUP of standard specifications on oxychloride flooring approved as American Standard by the American Standards Assn. are now available in reprint form. These specifications are designated and titled as follows:

A 88.1-1951 Standard Specifications for Preparation of Subfloors to Receive Oxychloride Composition Flooring
A 88.2-1952 Standard Specifications for General Purpose Oxychloride Composition Flooring and Its Installation
A 88.3-1952 Standard Specifications for Heavy Duty Oxychloride Composition Flooring and its Installation
A 88.4-1952 Standard Specifications for Base Coat Oxychloride Composition Flooring
A 88.5-1952 Standard Specification for Nonslip Oxychloride Composition Flooring and Its Installation
A 88.6-1952 Standard Specifications for Terrazzo Oxychloride Composition Flooring and Its Installation
A 88.7-1952 Standard Specifications for Industrial Granolithic Oxychloride Composition Flooring and Its Installation
A 88.8-1952 Standard Specifications for Oxycement Underlayment and Its Installation

These specifications were prepared by Sectional Committee on Magnesium Oxychloride Cement Flooring, ASA Project A88, sponsored by the ASTM and the National Bureau of Standards.

The first four standards, A 88.1 to A 88.4, inclusive, are published under one cover, priced at 85 cents per set. The remaining standards are published separately and are priced at 35 cents per copy. Copies are obtainable at the Society or from the American Standards Assn., 70 E. 45th St., New York 17, N. Y.

To ASTM Members: Your help is needed in maintaining that constant increase in ASTM Membership

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To the ASTM Committee on Membership,
1916 Race St., Philadelphia, 3, Pa.

Gentlemen:

Please send information on membership to the company or individual indicated below:

_____

_____

This company or individual is interested in the following subjects: indicate field of activity, that is, petroleum, steels, non-ferrous, etc.

_____

Signed _____

Date _____ **Address** _____

Technical Committee Notes

Soil Conditioners—Cellulose—Concrete Pipe—Refractories

New Committee to Establish Standards in Rapidly Growing Soil Conditioner Field

IN THE past few years the soil conditioner field has been greatly disturbed by extravagant claims for various organic agents. The eventual consumer-producer reaction was to call upon several agricultural and technical societies in an effort to establish standards for such conditioners.

In September, 1952, the Board of Directors of ASTM authorized the organization of a committee on soil conditioners. An organizational group, which included representatives from the Association of Official Agricultural Chemists, the National Agricultural Chemicals Assn., the Soil Science Society of America, and the Dept. of Agriculture, was formed to initiate the establishing of this committee. This group recommended that AOAC and ASTM jointly sponsor the committee on soil conditioners.

The organizational meeting of the Joint Committee was held on September 3, at Ohio State University, Columbus Ohio. A group of 27 representatives from industry, state, and federal governments, universities, and consumers agreed upon the following tentative scope:

"The formulation of specifications and methods of testing of materials for the alteration of the physical properties of soil for agricultural and engineering purposes; the selection of acceptable nomenclature and the stimulation of research to accomplish the foregoing purposes."

The group discussions of the subcommittee and working group structure of the committee quickly disclosed the complex nature of the standards problem as applied to soil conditioners. Two separate views for testing soil conditioners were evident. The first, from an official point of view of analysis for amount of active ingredient, and the second, from the view of performance tests.

Performance tests appear to be definitely in need of the greatest consideration since entirely different agents may cause similar results by dissimilar means. Analysis of conditioners for active content involves difficult analytical procedures particularly among the long-chain polymers. Similar problems are present in testing relative quality of natural soil conditioners. Two working subcommittees, on Methods of Testing and Nomenclature, were authorized.

The meeting concluded with a field trip to the Ohio State soil conditioner plots on the Agricultural School farm.

The Executive subcommittee will meet in Dallas, Tex., during the week of November 15, 1953, in connection with a meeting of the soil Science Society of America.

Temporary officers were elected as follows: *Chairman*, W. P. Martin, Ohio State University; *Vice-Chairman*, W. A. Raney, Mississippi State College; and *Secretary*, H. N. Stevens, B. F. Goodrich Co.

The initial membership list is as follows:

L. T. Alexander, USDA Bureau of Plant Industry
R. H. Beatty, American Chemical Paint Co.
L. H. Burt, Hercules Powder Co.
F. D. Caldis, California Packing Corp.
John Carter, Battelle Memorial Institute
M. D. Catton, Portland Cement Assn.
N. T. Coleman, North Carolina State College
J. D. Dalton, American Cyanamid Co.
A. E. Erickson, Michigan State College
J. C. Engibous, Monsanto Chemical Co.
W. H. Fuller, University of Arizona
W. H. Gardner, University of Washington
C. F. Gerlach, Wyandotte Chemicals Corp.
H. A. Hashbarger, Monsanto Chemical Co.
R. P. Hopkins, Rohm and Haas Co.
K. B. Hough, Cornell University
Donald Kirkham, Iowa State College
W. T. Lambe, Mass. Institute of Technology
J. W. Lang, General Aniline & Film Co.
E. M. Learner, B. F. Goodrich Co.
W. H. MacIntire, University of Tennessee
J. P. Martin, Citrus Experiment Station, California
W. P. Martin, Ohio State University
C. J. Mighton, E. I. du Pont de Nemours & Co.
R. D. Miller, Cornell University
F. W. Quackenbush, AOAC
W. A. Raney, Mississippi State College
Victor Renner, O. M. Scott & Sons Co.
E. Reeve, Campbell Soup Co.
L. Shapiro, American Polymer Co.
C. S. Slater, USDA Bureau of Plant Industry
K. L. Smith, Carbide & Chemicals Co.
H. N. Stevens, B. F. Goodrich Co.
C. L. W. Swanson, Conn. Agricultural Experiment Station
G. S. Taylor, Ohio State University
S. A. Taylor, Utah State Agriculture College
S. J. Toth, Rutgers University
K. B. Woods, Purdue University

Specifications for Concrete Low-Head Pressure Pipe Near Completion in C-13

SPECIFICATIONS for two classes of concrete pipe in the low-head pressure field have advanced to final draft form as reported at the meeting of Committee C-13 on Concrete Pipe, held at the Hotel Sherman, Chicago, Ill., on September 15 and 16. These specifications are being prepared for reinforced concrete low-head pressure pipe for use in the construction of conduits with internal hydrostatic heads generally not exceeding 100 ft, and for reinforced concrete low-head pressure sewer pipe intended for use in the conveyance of sewage, industrial wastes and storm water, under operating head up to and including 50 ft. These drafts will now be circulated for subcommittee letter ballot and then for committee review.

The two-day meeting was attended by 35 members and visitors, indicating great interest on the part of the industry in the Committee's activities. Several members from the West Coast were in attendance. The principal subject of consideration and discussion was the existing standard specifications for concrete pipe, namely, C 14, C 75, C 76, and C 118. A need for a complete review of these four specifications was expressed, in order that they may continue to hold their position as nationally accepted standards in the concrete pipe field. Many details of each specification were discussed at considerable length, and certain recommendations for tentative revisions were accepted at the meeting. In addition, special task groups were authorized to make a complete study of each standard specification.

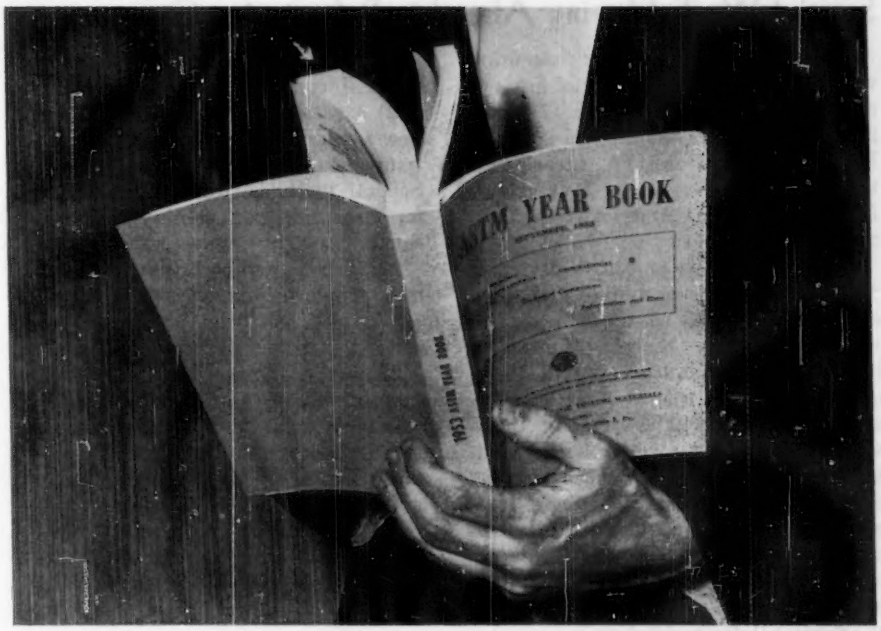
Included in the consideration was the matter of setting up limits of variation in squareness of pipe ends. A tentative revision was approved to add to Table III of Specification C 14 allowable variations ranging from $\frac{1}{4}$ to $\frac{3}{8}$ in. according to the various sizes of pipe. An additional tentative revision was

approved, adding a statement to Section 30 of Specification C 75 and Section 32 of Specification C 76, which will limit the variations in laying lengths of two opposite sides of a pipe to not more than $\frac{1}{8}$ in. per foot of diameter with a maximum of $\frac{5}{8}$ in. in any length of pipe. Recognition of the use of tongue and groove pipe is made through the acceptance of a tentative revision in the form of a footnote to Specification C 14, as well as adding a column to Table II to provide for allowable thickness of barrel for extra strength pipe.

The matter of steel area in reinforced concrete pipe was reviewed at some length, and a tentative revision was accepted covering two points: one being to change the form of tabulation of total steel area in Table I of Specification C 76 to conform with the corresponding table of Specification C 75, wherein the total steel area is in terms of "2 lines totaling" rather than "2 lines each"; the second, to add a footnote to Table I of Specification C 75 and C 76 to indicate that not less than 50 per cent nor more than 60 per cent of the total area of steel is allowable in the inner cage. A further tentative revision was agreed upon, affecting all four pipe specifications, which will change the wording of the acceptance clauses, as well as the requirements for retests.

An important change was agreed upon with respect to preliminary tests on pipe. Considerable study has been given to the substitution of cores in place of test cylinders in the larger size pipe. The committee approved a recommended revision of Specifications C 75 and C 76 relating to Sections 20 and 21, respectively, which would be rewritten in terms of providing for the use of cores and eliminating reference to test cylinders on large size pipe of 72 in. diameter and over, and provision will be made whereby the use of cores in pipe sizes below 72 in. will be optional. It will be indicated that the core holes are to be sealed and that the pipe may then be used. This action is subject to further preparation and final letter ballot of the committee. Letter ballots will also be conducted on all other tentative revisions authorized at this meeting.

A new field of standardization was discussed, namely, the preparation of a specification for precast concrete manholes. A study group was authorized to consider the feasibility of a specification for precast concrete access manhole sections, and will report at the next meeting. With considerable concrete pipe being used for drainage purposes, it was recommended that a change in scope of the committee to provide for this usage be presented to the Board of Directors of the Society.



It has often been said that the technical committees are the lifeblood of ASTM both in their contributions to research and to standardization. This photograph of the 1953 Year Book illustrates the tremendous extent of committee activity, the arrow indicating that portion of the Year Book required to list committee personnel—330 pages. This compares to the 174 pages, also shown in the picture, required to list the Society members alphabetically. In addition to these lists which include a large number of the country's—in fact, the world's—authorities on materials, the 640-page Year Book contains among other information, the Charter and By-Laws of the Society, District Council and Administrative Committee personnel, and a geographical breakdown of membership. Copies are available free of charge to members who request them.

Standardization Work Well Under Way in Young Cellulose Committee

THE fine progress of work of Committee D-23 on Cellulose and Cellulose Derivatives was emphasized by Chairman Forrest Simmonds at the committee's meeting in Chicago, Ill., on September 10. The extent of progress in the still early stages of existence of the new committee is reflected in the several reports presented.

The subcommittees reported as follows:

Subcommittee II on Cellulose.—Test methods being prepared include: Determination of alkali solubility of cellulose, determination of alpha-, beta-, and gamma-cellulose; determination for moisture content of cellulose; and color test of cellulose. Work is in progress for the formulation of sampling methods for cellulose products.

Subcommittee III on Organic Esters.—The Test Method for Cellulose Acetate (D 871 – 48) is being revised. A new test method on viscosity determination prepared in collaboration with Subcommittee IV has been completed. A method of test for cellulose acetate butyrate is to be written in collaboration with Committee D-20. Projected test methods are being considered for color and haze of cellulose and its derivatives.

Subcommittee IV on Inorganic Esters.—A revision of the Specifications and Tests for Soluble Nitrocellulose (D 301 – 50) has been prepared and will shortly be presented to the Administrative Committee on Standards. A determination of viscosity of cellulose and cellulose products by the ball-drop method has been completed.

Subcommittee V on Cellulose Esters.—Test methods for methyl cellulose, analysis for purity of carboxymethylcellulose, and degree of substitution in carboxymethylcellulose, are being completed.

Subcommittee VI on Statistics.—A review was given pointing out the fields in Committee D-23 which could be most propitiously studied from a statistical point of view. The work of this subcommittee will develop as the committee becomes more involved with sampling techniques.

The next meeting of the committee will be held in September, 1954, in New York, N. Y., in conjunction with the annual meeting of the American Chemical Society.

Special Work Moving Ahead in Refractories Group

CONSIDERABLE attention was given to the several special fields of refractories at the September 17 Meeting of Committee C-8 on Refractories at Bedford Springs Hotel, Pa., preceding a two-day session of the Refractories Division of the American Ceramic Society.

Long-awaited definitions of such special refractories as mullite and silica carbide refractories have now been developed and were accepted for letter ballot of the committee. With these definitions, there was also presented a method of chemical analysis of these special refractories, together with a load test method, which was referred to the Subcommittee on Tests for review. It is expected that the development of these standards will pave the way for more complete coverage in this field, including classifications, in close cooperation with the Special Refractories Assn.

Proposed methods of testing basic granular refractories are being completed and a number of suppliers of three types of dolomite have been requested to review these methods. There was considerable discussion over the status of semisilica brick, and it was the consensus that it be included in the classifications of fireclay brick.

Carbon refractories have also received considerable attention, and revisions to existing test methods are being proposed to include this type of refractory where necessary. For example, the reheat test (C 113) can be adapted, whereas the load test (C 133) does not require a change. The present thermal conductivity test method (C 182) is satisfactory up to 600 F, and a new test method is being developed for temperature ranges above 600 F. Several methods are being considered for measuring permeability and oxidation.

A much desired and useful outline on microscopic techniques in the study of refractories has been prepared, which will be distributed for review, and it is planned to include this outline in the next edition of the Manual on ASTM Standards on Refractory Materials. A special task group was authorized to study the need for a specification on ladle brick, as well as classification.

The next meeting of the committee will be held in conjunction with the Group Meeting of the Society in Washington, D. C., during the week of February 1, 1954.

New Aviation Gasoline Color Standard Available

THE new 108/135 grade of aviation fuel, added this year to ASTM Tentative Specifications for Aviation Gasoline (D 910 – 52 T), requires the use of an additional color comparison standard. For this new grade there will be two color standards, a maximum and a minimum, which will be furnished in 1-gal cans. These can be ordered direct from ASTM Headquarters, 1916 Race St., Philadelphia, Pa.

Calendar of Other Societies' Events

"Long" and "short" calendars will appear in alternate BULLETINS. The "short" calendar notes meetings in the few immediate weeks ahead—The "long" calendar for months ahead.

AMERICAN OIL CHEMISTS SOCIETY—Nov. 2–4, Fall Meeting, Sherman Hotel, Chicago, Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Nov. 2–6, Fall General Meeting, Hotel Muehlebach, Kansas City, Mo.

SOCIETY OF AUTOMOTIVE ENGINEERS—Nov. 2–6, Conrad Hilton Hotel, Chicago, Ill.

AMERICAN PETROLEUM INSTITUTE—Nov. 9–12, 33rd Annual Meeting, Conrad Hilton Hotel and Palmer House, Chicago, Ill.

THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS—Nov. 12–13, 61st Annual Meeting, Waldorf-Astoria, New York, N. Y.

SOIL SCIENCE SOCIETY OF AMERICA—Nov. 16–20, Annual Meeting, Hotel Baker, Dallas, Tex.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS—Nov. 29–Dec. 4, Annual Meeting, Statler Hotel, New York City, N. Y.

EXPOSITION OF CHEMICAL INDUSTRIES—Nov. 30–Dec. 5, Commercial Museum, Philadelphia, Pa.

THE AMERICAN SOCIETY OF REFRIGERATING ENGINEERS—Dec. 6–9, 49th Annual Meeting, Shoreham Hotel, Washington, D. C.

CHEMICAL SPECIALTIES MANUFACTURERS ASSN.—Dec. 7–8, 40th Annual Meeting, Mayflower Hotel, Washington, D. C.

SCIENTIFIC APPARATUS MAKERS ASSN.—Dec. 7–10, Midyear Meeting of Laboratory Apparatus, Laboratory Equipment, and Optical Sections, Boca Raton Club, Boca Raton, Fla.

AMERICAN CHEMICAL SOCIETY—Dec. 10–12, Southwest Regional Meeting and 5th Southwide Chemical Conference, New Orleans, La.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS—Dec. 13–16, Annual Meeting, Hotel Jefferson, St. Louis

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—Dec. 26–31, Annual Meeting, Boston, Mass.

STUDENT MEMBERSHIP PRIZE AWARDS—MERIT SPONSORSHIP

EACH ASTM member is urged to consider this very practical way of helping the engineering student, the engineering school, and the Society.

If interested in establishing such awards at your local engineering school or alma mater, return this form, and information will be sent.

A number of ASTM members pay the cost ($2 annually) of Student Memberships which are awarded on recommendation of the faculties to worthy students at various schools.

To the ASTM Committee on Membership,
1916 Race St., Philadelphia 3, Pa.

Gentlemen:

Please send me information on the establishment of STUDENT MEMBERSHIP PRIZE AWARDS.

Signed _____
Address _____

Date _____

The Journal of Photographic Science

FOR those concerned with industrial applications of photography such as radiography, photomicrography, spectroscopy, electron microscopy, high-speed photography, etc., this Journal issued every two months should prove a source of interesting information.

The *Journal of Photographic Science* is Section B of the *Photographic Journal*, an official publication of The Royal Photographic Society of Great Britain and The Photographic Alliance, 16 Princes Gate, London, S. W. 7.

As an example of the subjects included in a single issue, the March–April, 1953, covered: nuclear emulsion technique, stereoscopic projection, physics of the developed image, electron microscopy, and medical radiography, and document copying.

Subscriptions may start at any time during the year at a price of 25 shillings, post free, to nonmembers of the Royal Photographic Society. Single copies may be purchased for five shillings, post free.

More Unsolved Problems . . .

Intriguing Questions from the Committees— What We Know and What We'd Like to Know

ABOUT three years ago the ASTM Administrative Committee on Research requested the various technical committees to submit their current research problems. These statements were reviewed by the ACR and the decision taken that such problems be published serially in the ASTM BULLETIN and reprinted for distribution to various engineering and scientific schools and to research institutions and testing laboratories as a suggested basis for possible research work.

This reprint pamphlet has been revised and expanded to include additional problems which are also being printed in the present series of BULLETINS.

The revised pamphlet can be obtained from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

Appearing in this issue are:

Microthrowing Power in Electroplating

Statement of Unsolved Problem Contributed by Committee B-8 on Electrodeposited Metallic Coatings

Problem:

The phenomenon of microthrowing power in the electrodeposition of metals is but little understood, yet it has immense significance in the production of smooth and bright electrodeposits. Utilization of microthrowing power offers the possibility of reducing much of the expensive hand labor which is required in the preparation of workpieces prior to electroplating.

Present State of Knowledge:

Substantially nothing is known from a fundamental viewpoint. The phenomenon of microthrowing power has been observed in the course of practical plating operations and some empirical data have been gathered by C. E. Reinhard (1) on the effects of bath composition and plating variables on microthrowing power. There has been nothing except the vaguest speculation on the mechanism of the phenomenon and there can not be until investigations whose primary objective is to yield fundamental data have been devised and executed.

Questions That Need to Be Answered:

1. What is the mechanism which causes microthrowing power to differ so markedly from macrothrowing power?
2. Is microthrowing power influenced by the nature of either the anions or cations in the solution?
3. Does the nature of the basis metal enter the phenomenon of microthrowing power?
4. What are the relationships between the geometry of the basis metal surface and microthrowing power?
5. Will a basic understanding of microthrowing power be of assistance in formulating and operating electroplating solutions with exceptional leveling ability?

Introductory Reference:

(1) C. E. Reinhard, "Some Observations of the Microthrowing Power of Plating Solutions," *Proceedings*, Am. Electroplaters' Soc., Vol. 37, pp. 171–182 (1950).

Additional information may be obtained from Harold J. Read, Professor of Physical Metallurgy, The Pennsylvania State College, State College, Pa.

Effect of Alkali Vapors on Alumina-Silica Refractories

Statement of Unsolved Problems Contributed by Committee C-8 on Refractories

Problem:

To develop a laboratory testing method which will allow prediction of the serviceability of refractories in furnaces whose atmospheres carry alkalies to them.

Present State of Knowledge:

Alkali attack is a condition of service in glass tanks, blast furnaces and their stoves, coke ovens and elsewhere. The alkalies react with the refractories to form an outer reaction layer which may recrystallize to form new minerals, or may (if the temperature is high enough) melt and flow away.

In well-documented cases resultant minerals are nephelite ($Na_2O \cdot Al_2O_3 \cdot 2SiO_2$) and kaliophilite ($K_2O \cdot Al_2O_3 \cdot 2SiO_2$). Their formation on the surface of an alumina-silica refractory may result in the shelling or peeling of the reacted layer. Unpredictably, under similar conditions, this may not occur.

The alkalies may penetrate deeply into the refractory, or in other cases may be confined to a very shallow layer. The conditions of temperature, refractory composition, or physical properties, which govern these matters are not well known.

Questions That Need to Be Answered:

The need is for a test which will allow prediction of the way in which any refractory will behave, subjected to alkalies, at a known temperature.

Introductory References:

(1) E. P. Rexford and C. L. Thompson, "A Study of an Alumina-Silica Checker Brick from the Regenerator of a Glass Tank," *Journal*, Am. Ceramic Soc., Vol. 21, p. 55 (1938).

(2) H. M. Kraner, "Refractories Service Conditions in the Blast Furnace," *Journal*, Am. Ceramic Soc., Vol. 25, p. 311 (1942).

(3) F. H. Clews, A. Green, and A. T. Green, "The Action of Alkalies on Refractory Materials; Part I" (many other parts appearing in the following five years), "The Action of Potash Vapor on Refractory Materials at 900 C and 1000 C," *Transactions*, British Ceramic Soc., Vol. 34, p. 436 (1934–35).

Additional information may be obtained from R. E. Birch, Chairman of Subcommittee II on Research of Committee C-8, Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh 22, Pa.

Effect of Cooling Rate During Manufacture on the Properties of Fireclay and High Aluminum Refractories

Statement of Unsolved Problem Contributed by Committee C-8 on Refractories

Problem:

Control of the heating rate during firing of fireclay and high alumina refractories has always been practiced more exactingly than control of the cooling cycle. The problem is to determine the effect of rapid *versus* slow cooling on properties of these classes of refractories, with particular reference to the effect on spalling behavior. A firing schedule can be visualized in which the critical temperature ranges during cooling are just as well understood as those during heating.

Present State of Knowledge:

The phase transformations which occur in the crystalline components of refractories are usually reversible. High temperature modifications of crystals may also be produced by firing and these may subsequently undergo transformations during cooling. When a glassy phase is developed in addition to crystalline phases, it may have an annealing range and a devitrification range just like a completely

glassy material has. Devitrification may result in the formation of a new crystal phase with its associated phase modifications when reheated.

The state of residual strain distribution remaining in the refractory shape is a function of these changes, and of the rate at which the piece is cooled through the temperature range in which the changes occur. There is evidence to indicate that the state of strain distribution affects any property of the refractory which depends on its mechanical properties. That is, the apparent strength, elasticity, and thermal expansion may be definitely affected; thus resistance to spalling would be expected to be affected. The effects might not necessarily be detrimental to utility. In at least one case the apparent spalling tendency of a fireclay refractory was shown to be related to the tendency for the glassy phase to devitrify to form cristobalite (see references below).

Questions That Need to Be Answered:

1. How can the existence of a residual strain distribution be quantitatively established in a refractory?
2. Is there correlation between residual strain patterns and properties of the refractory (strength, elasticity, thermal expansion, spalling behavior)?
3. Can this strain distribution be affected in conventional type kilns by controlling the cooling cycle?
4. What type of data is necessary to establish the optimum cooling schedule for any particular type of fireclay or high alumina brick?
5. What is the effect of repeated reheat and subsequent associated cooling cycles?

Introductory References:

(1) W. A. Weyl, "Thermal History of the Glassy Phase and Its Effect Upon Physical Properties," *Bulletin*, Am. Ceramic Soc., Vol. 18, pp. 416–419 (1939).

(2) W. D. Fitzpatrick and R. K. Hursh, "Properties of the Glassy Phase in Alumina-Silica Refractories," *Bulletin*, Am. Ceramic Soc., Vol. 30, p. 101 (1951).

Additional information may be obtained from R. E. Birch, Chairman of Subcommittee II on Research of Committee C-8, Harbison-Walker Refractories Co., Farmers Bank Bldg., Pittsburgh 22, Pa.

Storage Stability of Oils Containing Pour Point Depressants Under Fluctuating Temperature Conditions

Statement of Unsolved Problem Contributed by Committee D-2 on Petroleum Products and Lubricants

Problem:

The ability of a lubricating oil to pour from a container is an important commercial property. When this property is measured in a standard test jar of prescribed dimensions and the oil is chilled at a controlled rate, we have the elements of the ASTM pour test D 97 – 47 (1). "The pour point of an oil gives an indication of the temperature below which it might not be possible to pour or remove an oil from its container or below which it might be dangerous to use the oil in gravity lubricating systems where the head tending to produce flow is small" (2). The practical aspects of pour point and of viscosity should not be confused. The ability of an engine to start at low temperatures is largely related to the viscosity at the low starting temperatures as extrapolated on the ASTM chart (3).

The present ASTM method for cloud and pour points is adequate for neutrals and bright stocks which do not contain pour point depressants. It is inadequate for unfiltered cylinder stocks and unrefined residuals which contain natural pour point depressants and for oils containing added synthetic pour point depressants. When such oils are stored under fluctuating temperature conditions, as in winter storage, they tend to become solid at temperatures considerably higher than those predicted by the ASTM Method D 97 – 47. This phenomenon has been termed pour point reversion, signifying the tendency of the oil to revert to its original uninhibited pour point. The main problem, therefore, is to attain a more complete understanding of the mechanism by which pour point depressants function, which should thereby serve as a guide in designing a more suitable test for predicting the storage behavior of such oils.

Present State of Knowledge:

Since actual field experience has emphasized the important rôle of temperature fluctuations in causing this anomalous behavior, considerable test work has been done along this line. A review of this work was published in 1946 (4). Although an improved method was developed at that time, it was still unsatisfactory. More recently the Esso laboratories developed several cycling temperature tests (5) which have been under study by ASTM Committee D-2.

The general theory which has been offered to explain the mechanism of pour point depression and reversion is based on adsorption and desorption phenomena. As an oil is cooled, the pour point depressant is adsorbed on the wax which is precipitated. This adsorbed depressant, in some way, prevents the wax crystals from growing to their usual long, needle-like structure. This reduced crystal size has been demonstrated repeatedly by microscopic studies. The wax-oil system at this point is in a relatively unstable state of equilibrium, since the original pour point has been lowered by a reduction in the size of the wax crystals. Such a system would be expected to be very susceptible to temperature changes. Thus, if the oil is slowly warmed to the region of the cloud point, the pour depressant would desorb from the wax and part of the wax would tend to redissolve in the oil. As the oil is again cooled, the depressant would have more difficulty in adsorbing on the portion of wax which is again precipitated. This wax is then free to grow to the normally large crystals which swell, agglomerate, and immobilize flow.

Questions That Need to Be Answered:

Although microscopic studies in various oil companies' laboratories have been useful in demonstrating some of the changes which occur when an oil is cooled in the presence of a pour depressant, there is a need for more basic information to explain:

1. How adsorption actually takes place.
2. Whether desorption actually occurs.
3. Why certain polymeric structures are required to obtain the greatest effect as a pour point depressant.
4. Possible relationship between solidification temperature of the pour depressant and of the wax in pure hydrocarbons.
5. Effect of viscosity.

It has been suggested that performing the pour test in an ultrasonic field might facilitate the coalescing of the wax aggregates. The problem of predicting the highest temperature at which an oil will solidify in practical service is of great importance to industry and to the Armed Services and is worthy of the considered attention of investigators in this field.

Introductory References:

(1) 1952 Book of ASTM Standards, Part 5, p. 51.

(2) Symposium on Motor Lubricants, p. 45, Am. Soc. Testing Mats. (1933). (Symposium issued as separate publication, *STP No. 33.*)

(3) *Ibid.*, p. 47.

(4) J. J. Giammaria, "Laboratory Determined Pour Points of Lubricating Oils as Related to Ability to Flow Under Field Storage Conditions," ASTM BULLETIN, No. 138, January, 1946, p. 44.

(5) J. G. McNab, D. T. Rogers, A. E. Michaels, and C. E. Hodges, "The Pour Stability Characteristics of Winter Grade Motor Oils," *SAE Quarterly Transactions*, January, 1948, Vol. 2, No. 1, p. 34.

(6) C. E. Hodges and D. T. Rogers, "Some New Aspects of Pour Depressant Treated Oils," *Oil and Gas Journal*, October 4, 1947, p. 89.

Additional information may be obtained from L. C. Beard, Jr., Socony-Vacuum Oil Co., 26 Broadway, New York 4, New York.

Correction

OUR attention has been called to an error which developed in composing the set of equilibria appearing on page 47 of the July, 1953, ASTM BULLETIN, in the paper by J. D. McGilvery on "The Temperature Rise Test to Determine the Relative Amounts of Phases I and II in Sodium Triphosphate." The data should have been arranged as follows:

$$5Na^+ + (P_3O_{10})^{-5} \leftrightarrows 5(Na\cdot xH_2O)^+ + (P_3O_{10}\cdot yH_2O)^{-5}$$

$$(A) \uparrow\downarrow \qquad\qquad \uparrow\downarrow (C)$$

$$Na_5P_3O_{10}(s) \qquad\qquad NaP_3O_{10}\cdot 6H_2O(s)$$

Refrigeration Data Book—Applications Volume

REFRIGERATING Data Books published by the American Society of Refrigerating Engineers, beginning in 1932, became so voluminous that starting in 1940 it was decided to publish two data books in alternate years, dividing the material contained in these books into two broad general classifications. The 1951 Refrigeration Data Book, Basic Volume, was intended to cover primarily the field of design including the science and art of refrigeration proper, refrigeration cycles, kinds of machinery and equipment used to extract or exchange heat, etc.

The 1952 Refrigeration Data Book, Applications Volume, covers the use of the science and art of refrigeration and the application of refrigerating machinery and assorted equipment to solve the user's needs. The 700-plus pages in this volume are devoted to 81 chapters. These chapters are grouped into eight sections.

Section I, Frozen Foods, includes theories of quick freezing and discussions of processing of fruits, vegetables, ice cream, fish, meat, and other foods.

Section II, Refrigeration in Food Manufacture, discusses refrigeration as related to milk plants, butter, cheese and candy manufacture, wine making, and carbonated beverages.

Section III, Refrigerated Warehouse Practice, discusses storage of the above foods as well as furs and fabrics, deterioration of stored products, and the use of locker plants.

Section IV, Refrigerated Food Distribution, covers currently available means of transporting foods while under refrigeration.

Section V, Low-Temperature Applications, includes chapters on preparation of blood plasma and use of low-temperature test equipment.

Section VI, Industrial Applications of Refrigeration, includes ice manufacture for skating rinks, refrigeration pipelines and cooling of electrodes in welding.

Section VII, Comfort Air Conditioning, describes the applications of refrigeration not only to stores and homes, but theaters, railroad passenger cars, busses, ships, and airplanes.

Section VIII, Industrial Air Conditioning, is similar to Section VII but is devoted to a description of refrigeration as applied to air conditioning in laboratories, printing plants, libraries, museums, hospitals, etc.

Two hundred and twenty pages at the back of the book are devoted to a "Refrigeration Classified Section" and would in itself be beneficial to an application engineer in the refrigeration field.

Copies of this book are available from the American Society of Refrigeration Engineers, 40 W. 40th St., New York 18, N. Y., at a cost of $7.50.

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Steam Contamination

FIVE papers on the subject of steam contamination, presented at the 1951 ASME Annual Meeting under the sponsorship of the Joint Research Committee on Boiler Feedwater Studies, have been assembled under one cover and published by the ASME. This symposium includes the following papers:

Correlation of Silica Carry-Over and Solubility Studies, by C. Jacklin and S. R. Browar

The Spectrophotometric Determination of Small Amounts of Soluble Silica in Water, by H. E. Robison, E. A. Pirsh, and Elizabeth J. Grimm

Adaptation of the Spectrophotometric Determination of Small Amounts of Soluble Silica in Water to the Determination of Undissolved Forms of Silica, by H. E. Robison, Elizabeth J. Grimm, and C. Brown

Field Testing of Steam Sampling Nozzles as Applied to Evaporator Vapor, by E. B. Morris

Influence of Boiler Design and Operation Conditions on Steam Contamination, by P. M. Brister, F. G. Raynor, and E. A. Pirsh

These papers can be obtained for $2 from the Research Department of The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

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Greater Cleveland Regional Dwelling House Code

THE Regional Planning Commission, serving the Cleveland metropolitan area, has published its Regional Dwelling House Code, devoted exclusively to single- and two-family dwellings. A group of 38 municipalities participated in the project.

While the code is concerned primarily with homes constructed in the conventional manner of wood interior framing and either wood-frame or masonry exterior walls, it does not exclude the use of other materials, methods, or types of construction, prefabricated homes receiving special consideration.

Performance objectives are used to a great extent, although specification requirements are also included to furnish a yardstick or indication of acceptable construction standards. Automatic provisions are made for the review and approval of new materials and construction procedures that meet the performance qualification.

References have been made to nationally accepted standards, such as ASTM, wherever applicable throughout the code. The identification of these standards is placed in one chapter, making it relatively simple and convenient to amend only this one chapter to bring the code up to date on latest accepted national standards.

Copies may be obtained at $5 each from the Regional Planning Commission, 415 The Arcade, Cleveland 14, Ohio.

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The Control of Quality of Ready-Mixed Concrete

THIS manual is a guide to both purchaser and producer of ready-mixed concrete. Following a discussion of materials, control, and basis of purchase, the manual sets forth essential information for preparation of concrete. Chapters on computing batch weights, proportioning concrete, control of operations, and tests, are thoroughly expounded complete with all applicable ASTM Specifications.

This 76-page manual can be obtained from the National Ready Mixed Concrete Assn., 1325 E Street, N. W., Washington 4, D. C., for 75 cents.

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Tables of Normal Probability Functions

THIS 344-page publication of the National Bureau of Standards Applied Mathematics Series 23 is a reprinting of the highly accurate tables in MT14 which is now out of print. The normal probability function occurs in a wide variety of statistical applications. Thus, while one use of these tables is in testing the significance of a deviation in a normally distributed variate and in fitting normal distributions to observations, these many-place tables are prepared and made widely available because they serve as a practical basis for computation of related functions.

Copies can be obtained from the Government Printing Office, Washington D. C., for $2.75.

British Plastics Year Book 1953

THE new edition of the only classified guide to the products of the British plastics industry contains lists of manufacturers of plastics materials and products; proprietary products; a directory of manufacturers and individuals in the plastics field.

Also included is a review of patents, issued in the past year, which are abstracted and arranged in subject groups.

The Year Book is arranged in convenient handbook form. Copies can be obtained from the publishers, Iliffe & Sons Ltd., Dorset House, Stamford St., London S.E. 1, for 30 s.

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Proceedings, Highway Research Board

THE Society Headquarters has received the 1952 *Proceedings* of the Highway Research Board's, 31st annual meeting containing papers concerning economics, design, constructions, materials, maintenance, soils, traffic, and operations problems of highway research. Copies may be had by addressing National Academy of Sciences, National Research Council, Pub. 238, Washington, D. C.

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New ECPD Publication

"ENGINEERING—A Creative Profession" is a recent publication of the Engineers Council for Professional Development, intended to replace "Engineering as a Career."

Copies of this illustrated booklet which describes the various engineering fields and the preparation required to enter them, may be obtained from the ECPD, 29 W. 39th St., New York, N. Y., for 25 cents.

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Fire Safeguarding Warehouses

Technical Survey No. 1. Fire Prevention and Protection Survey of Warehousing and Storage Stockpiling. National Board of Fire Underwriters, 85 John St., New York 3, N. Y.

The Behaviour of Aluminum Alloy Riveted Joints

A. J. Francis. Research Report No. 15, The Aluminium Development Assn., 33 Grosvenor St., London W1. 95 pp. 7/6d.

1953 SAE Handbook

Committee Personnel, Standards, Recommended Practices, General Information Reports. Society of Automotive Engineers, 29 W. 39th St., New York 18, N. Y.

Corrosion of Low-Alloy Irons and Steels in Soils

A RECENT study by the National Bureau of Standards provides new information on the corrosion of certain low-alloy irons and steels in soils. Specimen plates (containing up to about 6 per cent of total alloying elements) of copper-molybdenum open-hearth irons, nickel-copper steels, and chromium steels with and without molybdenum, together with reference specimens of plan steel, were buried at 15 different test sites for periods up to 13 years. Sets of specimens were taken up at regular intervals, corrosion products removed, and weight losses and depths of deepest pits measured.

Steels containing 4 to 6 per cent chromium generally lost about half as much weight as did plain steel under the same conditions. However, the greater corrosion resistance of the alloy steels as measured by weight loss was not generally accompanied by a corresponding reduction in the maximum depth of pits. The least pitting was observed on specimens containing molybdenum in addition to chromium.

The change in the rate of pitting with time was found to depend on the composition of the steel. Although the initial rate of pitting was greater for the alloy steels, the depths of the deepest pits in the alloy steels were usually less than in the plain steel indicating that after the maximum period of exposure the alloying constituents induce the formation of corrosion products which tend to reduce the rate of pitting with time. In an environment unfavorable to the development of protective deposits of corrosion products, the alloy steels could be expected to develop deeper pits than plain steel because the greater initial rate of pitting of the alloy steels would tend to be maintained. This tendency toward accelerated pitting of alloy steels was actually observed in a few highly reducing soils in which the deposition of a protective scale was impossible because of the solubility of the corrosion products.

Lightning Resistance of Porcelain Insulators

ONE phase of a National Bureau of Standards investigation, dealing with the action of pintype porcelain distribution insulators during high-intensity electrical storms, has resulted in the development of a method for measuring the ability of these insulators to withstand lightning strokes. The method involves the generation of voltages similar in waveform to those appearing on lightning-struck power lines and the discharge of these potentials across an insulator at rates up to 11 million volts per microsecond.

During the preliminary investigations, no punctures were obtained on the first application of a surge voltage to an insulator, even when the steepest rates of voltage rise were used. However, several insulators punctured after repeated applications, some with rates of voltage rise as low as 3000 kv per microsecond. Consequently, in the method finally selected eight equal voltage surges are applied at 20-sec intervals to each insulator.

The bureau has further studies in progress, but before standards can be adopted, the various laboratories must agree on experimental procedures for generating and measuring the necessary voltage surges.

Permeability of Firebrick

USING a permeammeter of improved design, the National Bureau of Standards completed a study of permeability to room temperature air of various firebrick and refractory-clay pots manufactured in the United States and used for melting glass. Permeability is expressed in terms of the flow of air in cubic centimeters per second that will pass through two opposite faces of a 1-cm cube, when the pressure between the two faces of the specimen is 1 g per sq cm.

Permeabilities were determined for eleven types of firebrick: insulating, super-duty fire-clay, high-duty fire-clay, mullite, acid-proof silica, magnesite, chrome-magnesite, magnesite-chrome, kaolin, and 60 per cent alumina. Permeability was generally lower flatwise than edgewise or endwise, probably because most of the firebrick were made by the dry-press process. Correlation between permeability and the other determined properties was low, but there was some tendency for higher permeability to be associated with higher porosity and with lower bulk density and modulus of elasticity.

Similar measurements were made on specimens cut from three slip-cast refractory-clay pots of the type used for making optical glass. Pots that in service showed high resistance to penetration by molten glass were found to be characterized by fine grain sizes and low permeability; high measured permeability was associated with high penetrability by molten glass. Permeability was a better criterion for resistance to attack by molten glass than was modulus of elasticity, porosity, or bulk density.

The Philosophy of Simulated Service Testing

By S. A. Gordon[1]

EDITOR'S NOTE.—"The Philosophy of Simulated Service Testing" is a paper which has been written as the result of a request by ASTM's Administrative Committee on Simulated Service Testing.

The Committee has for its functions the supervision of the development and standardization of methods of tests of simple or composite materials in actual or simulated service conditions and environment, in so far as performance has a bearing on the properties of the material. It is understood that this may involve the testing of processed parts under such conditions.

Mr. Gordon's paper is an attempt to clarify the philosophical approach that is most likely to yield the best results from a simulated service test. It is presented also to stimulate discussion.

AS YET, no better way of determining the behavior of a product has been developed than to submit it to actual service. All the ideas brought forth by the research and development work can then be critically evaluated. This is one way to conclude or reorientate a product development program. Whenever feasible, it is always an integrated part of product research itself.

First, a full-scale model must be constructed and placed in service. In order to take full advantage of the information gained, actual production should be postponed until all the improvements indicated by such testing can be incorporated. Such a procedure is rarely practical, so the next best method is to set up a simulated service test.

True simulated service testing assumes and requires a complete knowledge of the product, its environment, and its operational history. Collecting such knowledge is rather difficult, but the difficulty can be minimized by an approach whereby the scope of the environment is established and the important operational factors are identified. The purpose of this paper is to attempt to clarify the philosophical approach that is most likely to yield the best results from a simulated service test.

Consider first what the factors are that go to making up the simulated service test.

First, is the product predominantly dependent upon its own operation for good performance? A single-purpose automatic machine in a well-controlled air-conditioned factory, a grandfather's clock or electric clock, and a stationary power generator are examples of such a product.

Second, is the product predominantly dependent upon external sources for good performance? A shipping container, the structure of an airplane, and a truck body are examples of this type of product.

Third, is the product dependent upon both its own operation and its environment for good performance? An automobile engine, an airplane engine, a locomotive, and an automobile clock are examples of this type of product.

Now, what are the operation and environmental factors to be considered? Sometimes both of these factors are defined in the performance specifications; sometimes they are not. For instance, a specification for an aircraft features the airplane as having a speed of A mph, a climb of B ft per min, a ceiling of C ft, and ability to carry D lb of cargo and E number of passengers, take off in F ft, and land in G ft at H mph, and as being designed for I load factor. It should be designed for J ft per sec gust, and last K hr of flying time. Items A through I can be defined as operational characteristics and will be based on "standard conditions." Items J and K infer environmental conditions. On the other hand, the performance specification on a pocket watch may cover only size, cost, and accuracy, in which case no environmental conditions are inferred.

During the design and construction of the product, certain terms of the performance specification will be fulfilled automatically and can be confirmed by measurement, observation, or test. Other terms, however, such as life or durability, can be confirmed only by actual use under service or simulated service conditions. The time element in testing then becomes the factor that needs modification. One phase of the philosophy of the simulated service test is to attempt to prove, in a very short time, that a product will operate satisfactorily over a far greater period of time under its anticipated operating conditions.

If the original performance specifications are set up with the end use in mind, certain factors can be evaluated and considered properly in the early stages of design. Other factors, however, must await completion of the product for satisfactory service testing. To secure the best results from simulated service testing, the test program should be worked out at about the same time that the preliminary specifications are established. In fact, it might be advisable to establish the simulated

Fig. 1.—Some Factors Develop Automatically. . .

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Battelle Memorial Institute, Columbus, Ohio.

service test program first, before starting the design. This will force the designer to consider the end use with more emphasis than normally is exercised, and there will be less likelihood of omitting something important. This also will force the designer to establish what a reasonable requirement should be.

Referring to the three operational factors discussed above, let us consider each one separately, with emphasis on life.

Testing Where Environment Is Not a Factor

There is really no case where environment does not influence the operation of a product. However, if the environment is not a variable factor, the simulated service test becomes relatively simple as soon as it is established. The variables are now in the machine alone, with no external complexities.

The grandfather's clock is in a room of limited temperature range and humidity; so is the single-purpose automatic machine. Both products perform on a repetitive and predictable cyclic history and, since the finished products cannot be speeded up to secure results in a short time interval, the approach in this case would be to study component parts prior to their installation. The clock spring that controls the pendulum oscillation represents a completely reversed alternating stress at 60 cpm. At this rate, years would be required to test the specimen to establish the endurance limit of the material selected. The obvious answer is to accelerate the test on the spring to some value consistent with available test equipment and time limitations. In this case, the simulated service test is established with the environment constant and the speed of testing increased. Then one can search the literature on the speed of testing to determine its effect. If the literature reveals too few data, the designer has found a field of needed research!

A more complex machine operating in a constant environment, of course, will present other problems, such as the effect of lubricating oils, the effect of internal temperature rise, the effect of complex loadings where the mean stress will vary, etc. All of these factors can be studied prior to complete construction of the product. If, for reasons of economy, it is necessary to study these factors on small-scale specimens, then size effect must be considered and its real existence proved.

Cases will arise wherein calculating the actual stresses on machine components is very difficult. This may be due to the complexity of the structure and the existence of secondary stresses which are, in most cases, impossible to calculate with any accuracy. Then the test may have to be run on a partially completed structure. In such a case, it might be difficult, if not inadvisable, to increase the speed of testing to much beyond the maximum operational speed. The next best procedure would be to determine the stresses by proper instrumentation and increase the stress amplitude to force failure in a shorter time interval. The reliability of the results of such a test depends upon many factors. If the test specimen has more than one possible mode of failure, a higher stress amplitude may seek out the stress raiser at which no failure would occur had the same specimen been tested for the lower stress amplitude. If residual stress of unknown magnitude exists, it may be difficult to identify the proper *S-N* curve for the basic material and stress conditions on which to predict the life for the actual stress level expected in service. If several stress amplitudes are involved, the effects of one on another may be different at different stress levels, though the stress ratios may be the same. All of these points and others that come up that might influence the results of such tests should be considered. The important point is that the variables can be identified by rational reasoning and the literature surveyed to find either the answers or the type of research which will yield the answers.

Because the environmental conditions in this type of simulated service testing are constant, the factors, when equivalent, then may represent quite well those which exist in the standard run-of-the-mill type of laboratory fatigue test. Much of the laboratory data available today should then be directly applicable to the completed product merely by matching materials, heat treatments, surface conditions, and stress-concentration factors; this is true, but only when the actual stresses are known.

It becomes apparent from the above reasoning that certain conclusions can be arrived at readily in considering simulated service tests where the environment is constant:

1. The environment must have little, if any, effect on the results. A corrosive atmosphere, though constant, definitely will influence the results.
2. Much of the simulated service testing can be eliminated by proper reference to existing laboratory data, where actual stresses are known.
3. Logical reasoning will disclose the type of simulated service test that will be required where it is difficult either to determine the actual stresses or to simulate the operational history by simpler means. Then priority can be given these components and the tests started at any earlier date.
4. The service test must be planned from the design specifications prior to the start of design, or at least before construction.

Fig. 2.—Collecting Knowledge is Difficult. . .

Testing Where Environment Is the Only Factor

A shipping container loaded within its specifications will last indefinitely if it is never shipped. An air-frame structure will last years if the ship is never flown. In both cases, the life of the product depends entirely upon its environment.

A simulated service test where the environment is the only factor to be considered is much more difficult to set up than the first type, and the approach is entirely different. Here, the designer is confronted with the problem of predicting the magnitude and frequency of

occurrence of the oscillating loads. He must study everything but the product! In the case of the shipping container, he must know the shipping medium. Will it be a truck or railroad car; will the container be exposed to inclement weather in transit; what kind of handling will the container get? For the airframe structure, what are the gust magnitudes and frequencies? Even if such data are available, they must be considered statistically, and the degree of risk to be taken must be established.

A number of influencing factors must be considered which, collectively, will make a rather confusing picture. The designer's responsibility is to make sense out of this confusion and evolve a reasonable set of conditions which will represent the environment of the product. The conditions set up must be reproducible in the laboratory and still bear resemblance to the actual conditions. It is only in recent years that the effect of environment on simulated service testing has received active attention, and the information available is far from complete. Unfortunately, the time and expense involved in securing such environmental information usually cannot be borne by any one manufacturer and requires the complete cooperation of the users. To secure cooperation, the methods of obtaining service data must be simple and the data must cover a wide range of operation in any one field. Sufficient data should be available to lend themselves to statistical analyses.

In applying environmental information to laboratory use, it must be simplified, and the number of test conditions reduced to the minimum. A simulated service test on an airframe structure can be performed on only one specimen. However, the selection of the critical conditions may involve more than one stress amplitude and many involve stress levels and numbers of cycles which would take months to complete. A rational compromise in this case has been to select stress amplitudes close to the design yield load, thus producing failures in short periods of time. This procedure has provided very satisfactory results in that it has been a most effective means of reproducing service failures in a number of instances. The correlation of service failures with simulated service tests has been the most effective method, so far, of establishing the specifications of a service test for fatigue life in aircraft structures.

Certain interesting and somewhat disconcerting facts have developed from these limited repeated-load tests, however, that make it difficult to take advantage of the massive collection of laboratory fatigue data now available. For instance, it is very difficult, if not impossible to determine the actual stresses in the structure, even under known laboratory loading conditions. The number of cycles to cause a fatigue failure in the composite structure do not agree, by a large margin, with those for laboratory specimens. Even in cases where one full-scale element, such as a landing gear, where calculated stresses for known loads are reasonably reliable, is tested, poor correlation is obtained. Many investigators who have spent years in fatigue research admit now that full-scale testing is necessary—a strong argument for the simulated service test!

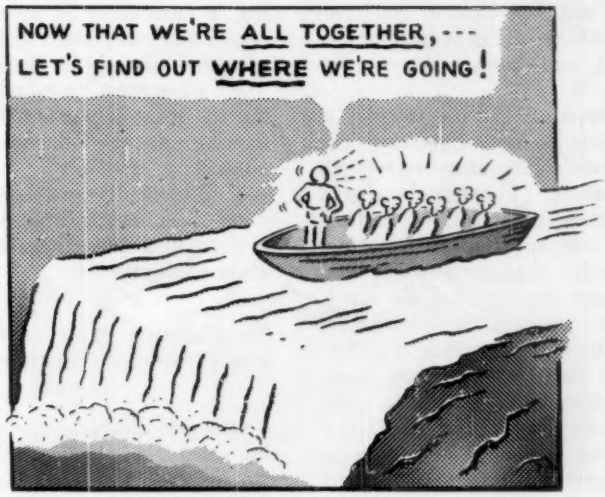

Fig. 3.—Seek *Guidance*,—Not Correlation!

Concluding the case for the simulated service test where the environment is the only influencing factor, it follows:

1. The environmental history must be known and should be the only influencing factor in the life of the product.
2. Full-scale components must be used in the test.
3. Very little direct use can be made of the results of laboratory tests now available to predict the life of a product.
4. Accurate and complete records must be kept of service failures and their histories if any advance is to be made in this type of life prediction.
5. Competitive groups in any one industry will find it highly desirable to pool their efforts in learning more about the environment of their products.

Testing Where the Environment and Product Operation Influence Product Life

An electric clock operating in a controlled atmosphere will last much longer than the same type of clock in an automobile, where the environment varies; hence, large temperature and humidity differences and, possibly, vibrations and shock must be considered if a simulated service test on an automobile clock is to mean anything.

By the same token, block testing an automobile or airplane engine tested for a given number of hours in a fixed environment does not represent the operating conditions, although such an acceptance test may be a satisfactory method of determining the best type of engine on a relative basis. More reliable results would be obtained if environmental conditions were included, such as variations in operating torque, frequent low-ambient-temperature starts, etc. How closely the environmental conditions can be duplicated depends upon the severity of the requirements and the size of the product. The automobile clock is small enough to be enclosed in a temperature and humidity chamber of reasonable size and cost, and the atmospheric conditions may be programmed to simulated actual conditions, except for the time interval, which can be speeded up. If corrosion is part of the environment, as it is in some applications, additional consideration must be given to this factor.

A much larger structure, such as an airplane, cannot be treated in the same manner conveniently. However, as pointed out before, the airframe structure does not fall into this category with regard to type of test, but some components, such as the hydraulic system, might. If the complete system is still quite large, certain components can be tested under the variable environment. The extent of such tests usually is limited by costs, and care must be exercised in selecting the critical sections for testing. If components are to be used for simulated service testing, care must be exercised to duplicate the supporting structure, as nearly as possible, so that the load distribution within the com-

ponent will simulate that in the complete installation. This is part of the environment and must not be overlooked.

In this type of service testing, it would be futile to try to correlate the results of simple laboratory tests with full-scale results. The basic material may be sensitive to strain aging, and the effects of overstressing and understressing under programmed cycling may not follow any rational law which would allow prediction of cumulative damage in the same materials of different sizes and shapes. Here again, however, the philosophy is not to seek correlation, but to seek guidance in the early stages of design. No miracle is going to compensate for initial ignorance or failure to take advantage of the information that was available!

Because of the complexities involved in programming the environmental conditions in this type of test, there is a strong tendency on the part of the designer to oversimplify the requirements and end up with a constant-environment test at some severe condition. This procedure automatically nullifies the effect of the environmental variable and, in many cases, will give results not applicable to actual service; for example, creep tests at high temperatures under constant load may produce entirely different results than would creep tests under cyclic temperature or cyclic loads. The designer must be cognizant of these facts.

Concluding the case for the simulated service test where the environment and product operation influence life, it follows:

1. A complete knowledge of both the product and its environment must be known.
2. In simplifying this type of testing, a false sense of security must be avoided in component testing if the environmental variable is made constant.
3. Care must be exercised in selecting the most important environmental variables, as they influence the life of the product.
4. Practically no laboratory test on small specimens will be of direct value in predicting life for structures falling under this category.

Relationship Between Small-Specimen Testing and Simulated Service Testing

Strangely enough, the designer will find much information in the annals of the hundred years of fatigue testing which may guide him during the early stages of design if he can relate the conditions of simulated service testing with those of laboratory test specimens. He will not find the answers in data on simple, laboratory test specimens, but he will find the proper guidance to help him select the best combinations of materials, surface finishes, stress concentrations, etc., in a given fixed environment to do the job. Laboratory fatigue testing through the years has been motivated by a real need and, therefore, the results should have value. The important point to consider is that these results are valuable only in guiding the design of a product during the preliminary stages. After the design has been completed and the product finished, such tests are of no further value. The final worth of the product is determined only in actual service, and a very well-planned simulated service test is of value only in predicting the final worth reasonably well. However, the more intelligently the designer plans his testing in the early stages, the more gratifying will be the results of the service test.

What can be most damaging in setting up a simulated service test is failure to consider all the important factors that influence the product's operation; however, too much conservatism in setting up the conditions is just as bad. For instance, it would be unreasonable to design an airplane to withstand 200,000 hr of flight when we know that the present utility of commercial airplanes is 3000 hr per year and the airplane probably will be retired in 15,000 to 25,000 hr because of obsolescence (this, of course, assumes that the life can be predicted). On the other hand, it would be just as unreasonable to design only to the expected minimum of 15,000 hr. Either extreme should be avoided. If conservatism is desired, and a reasonable amount should be, the conservatism should not be reflected in the simulated service requirement, but in the design; that is, the test must be reasonable to begin with. Thus, "overdesign" will be controlled better, and the ultimate cost will not be excessive.

An adamant designer may set up unreasonable requirements for the test and have it rejected by management because of its excessive costs and time. On the other hand, a simple test which is too optimistic will be acceptable to management but may fail to prevent service failures. Then it will become very difficult to justify other tests in the future. (A violin maker can have his violin tested by a student or a concert artist; the results will be vastly different.)

Since no one is perfect and always uses correct information in the correct place and ends up with a product whose performance can be predicted accurately, many guesses will have to be made, and some are bound to be bad. Then a failure will occur in service which will have to be remedied. In such cases, the solution will not always be readily apparent, and a simulated service test must be run on a duplicate of the failed component. First, the failure must be reproduced faithfully in the laboratory to insure that the environment has been simulated, and then a "fix" must be worked out. In such cases, the service conditions will have to be aggravated in order to speed up testing. If the failure is reproduced, then the aggravated conditions are proved to have been valid; if it is not, then either the environment has been evaluated improperly or the aggravated procedure is the wrong approach. For instance, aggravating a corrosion-fatigue failure may produce incorrect results. Often comparing the data of a simple

Fig. 4.—No Miracle Will Compensate for Initial Ignorance...

specimen with those of full-scale service tests will not yield usable conclusions, but may help guide the investigator in selecting a satisfactory "fix." Nevertheless, the final answer still must be obtained from a simulated service test. Should the investigator fail to reproduce the service failure after considerable effort, he may conclude that it cannot be done; this is possible, but not probable.

As an example, an aircraft company received many reports of service failures in the retracting knuckle of a landing gear. Many attempts were made to reproduce this failure, but without success. Instrumentation during testing disclosed no excessive stresses. The investigator had almost given up hope of solving the problem after many attempts at applying all possible service conditions, such as excessive misalignment, shock loading, simulating aggravated air loads, etc. It was not until an observer suggested rotating the wheels while retracting the gear that the failure was reproduced. Thus, the most important environmental variable was not included in the simulated service test conditions. Simple instructions to apply brakes before retracting corrected the condition.

If simulated service testing is conducted properly and the philosophy worked out carefully, the channels through which basic research should be guided will be indicated. If the testing is planned early enough, it will assist the designer in taking advantage of available basic laboratory information in detail design, where it will do the most good.

Simple laboratory tests will tell the designer the dangers of poor finishes, the effect of stress concentrations, the influence of certain controlled atmospheric conditions on various materials, the effect of clamping stresses, the influence of decarburization, shot peening, and various platings, and many other items important to the designer.

The simulated service test will tell the designer how well he evaluated all this information to develop a product which is "conceived for a purpose, designed with knowledge, built with understanding, and, if maintained with care and appreciated in performance, will live with pride."

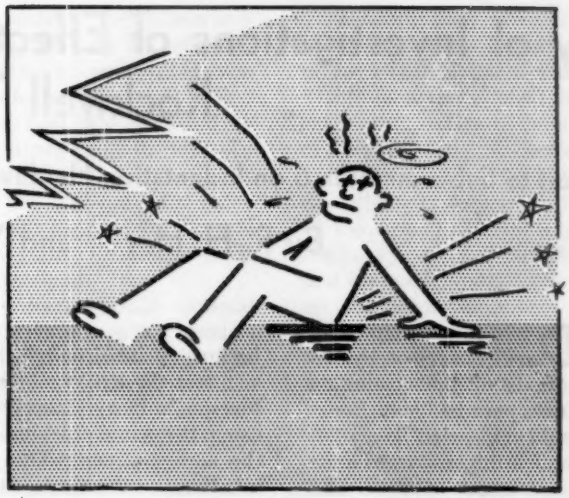

Fig. 5.—One Way to Conclude a Program. . .

DISCUSSION

ROBERT BURNS.[1]—Mr. Gordon has helped all testing technologists by devoting his paper to the philosophy of testing rather than attempting the futile task of outlining precisely how to test this or that. One of our common errors is to start testing, any kind of testing, before deciding whether or not testing is needed at all or how we should go about it. The result is millions of data, frequently useless—a waste of manpower and money.

The point of these comments is not to criticize, since the author is obviously a skilled workman in the science of testing. Instead I should like to emphasize the ghosts which haunt every design and materials engineer, namely, the twin specters of shipping and storage. The grandfather's clock and the single-purpose automatic machine will spend their lives in respectable environments and we would be happy indeed if we could engineer for such sedate surroundings. But, oh brother, before they get there!

We are told they will be dropped from boxcar to tailboard, from tailboard to ground. When grandfather has been dead for three years he'll look better than his clock after a trip from Akron to New York. Furthermore, between arrival and installation we are warned that the revered timepiece will be stored alongside a pipe carrying 275 lb of steam.

The result is of course that we overengineer but in the wrong places. Technical effort that should be applied to the mainspring is devoted to extra-strong chunks of material or elaborate cushioning devices all of which contribute nothing at all to performance. That we need Mr. Gordon's philosophy there is no doubt; we also need a nice gentle trucker who, if he must set our gadget alongside a large pipe will make sure said pipe is full of nothing more drastic than cold water.

[1] Technical Staff, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

Survey of Investigations of Effect of Specimen Thickness on Rockwell Tests

A Report to Subcommittee 6 on Indentation Hardness of Committee E-1 on Method of Testing

By R. H. Heyer[1] and V. E. Lysaght[2]

DETERMINATION by experimental methods of the mimimum specimen thickness permissible in Rockwell testing would appear to be a relatively simple and straightforward procedure. The experiences of those who have undertaken the task have proved otherwise.

This survey is presented as a correlated abstract to stimulate interest and ideas for future work. The survey includes important publications on the subject and some unpublished work which merits the attention of those concerned with limiting specimen thickness in Rockwell testing.

It should be emphasized that different groups perform hardness tests for different reasons, such as adherence to specification, process control, relation of hardness to tensile strength, and prediction of fabricating properties. Hence a limiting value of thickness of test specimen which is suitable for one purpose may not be suitable for another.

Thickness Limits of Rockwell Specimens for Reliable Empirical Rockwell *versus* Tensile Strength Relationships

Probably the earliest published detailed work on the effect of thickness on Rockwell hardness is that of Van Deusen, Shaw, and Davis (1).[3] Their objective was to obtain reliable relationships between Rockwell hardness and tensile strength of sheet brass. Their data indicated that useful relationships were obtained when the sheet thickness limits were grouped into two categories, 0.020 to 0.040 in., and over 0.040 in. Additional work by Townsend, Straw, and Davis, (2) confirmed the earlier conclusion that the tension test is the best available test for inclusion in specifications for non-ferrous sheet metal in the hard tempers, but because of its close relation to the tension test the Rockwell test was adopted for preliminary inspection purposes, using the same thickness ranges as in the earlier paper. The methods used in these investigations have been adopted for the development of most of the hardness specifications for copper and copper alloys. In some of these specifications the Rockwell Superficial test has been introduced, permitting tests on sheet thicknesses down to approximately 0.010 in.

Methods for Determining Minimum Specimen Thickness Limits for Rockwell Hardness Testing Using Specimens of Varying Thickness

In the foregoing investigations certain limiting thicknesses of sheets for Rockwell hardness tests were found necessary in establishing Rockwell-tensile strength relationships. The thickness limits selected were useful and adequate for the purpose, but they did not insure intrinsically correct hardness readings. In subsequent attempts to determine specimen thickness limits in Rockwell testing, the goal has usually been to find the minimum thickness which will give the same hardness reading as would be obtained on thick specimens of the same material.

Preparation of test specimens of uniform material in a range of thicknesses is always a difficult problem. Three methods of preparing test specimens are: (1) reduction of thickness by machining or grinding, (2) reduction of thickness by chemical attack, etching, or electropolishing, and (3) preparation of specimens of different thickness but of the same hardness by rolling and heat-treating procedures.

If the test specimens are prepared by rolling and heat-treating procedures designed to give uniform properties in a range of thicknesses, some test for uniformity of hardness is needed. Light load hardness tests, for example, 30-kg and lighter DPH (diamond pyramid hardness) tests, have been used to check uniformity. When the cross-section is surveyed by light load indentation hardness tests, surface to center variations are often found which could not be detected by tension tests. This may also be true of test specimens prepared by methods 1 and 2.

Specimen Thickness Limits for Low-Carbon Steel-Test Specimens Prepared by Etching

The first attempt to establish the effect of thickness on the accuracy of the Rockwell test was made by R. L. Kenyon (3). Summary statements from his paper follow:

"In the preparation of specimens for this test, a low-carbon killed steel was used of uniform composition and structure throughout its thickness. Variation in thickness was obtained by etching in acid and the surface was then polished.

"The appearance of a bulge under an impression on a polished specimen is evidence that such a Rockwell reading is questionable. The thickest specimen showing this is either the thinnest one that gives accurate hardness values or the thickest one that gives erroneous results due to thickness effect. The appearance of a bulge cannot be used as a criterion on etched surfaces and its application to polished specimens is principally of theoretical value. It is possible to determine a practical limiting thickness for various surfaces which will insure a maximum deviation of say two Rockwell numbers from the hardness of the material.

"On iron and steel the ridge around the spherical impression changes to a depression at a certain thickness of the specimen.

"There are apparently three influences that affect the Rockwell hardness reading on thin sheet; side flow causing lower readings, anvil effect causing higher readings, and crushing effect or 'punching through' causing lower readings. The intensity of these effects varies with thickness, and the reading obtained is the net result of all three superimposed on the hardness of the material.

"Decreasing the load (changing the Rockwell scale) makes it possible to obtain reliable readings on thinner pieces."

The thickness limits determined by Kenyon, shown in Fig. 1, indicate that polished test specimens can be tested in thinner sections than etched specimens.

Recent tests in the laboratory of one of the authors have shown that Rockwell tests on low-carbon steel sheets with finely ground surfaces are more reproducible, give higher hardness numbers, and are believed to be more accurate than tests on the same sheets with mill

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

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[3] The boldface numbers in parentheses refer to the list of references appended to this paper.

finished surfaces. The surface condition of the test specimen also influences the limiting thickness in which it can be tested with accuracy. Furthermore, Rockwell anvil material and the surface condition of the anvil have a marked influence on hardness readings when thin steel sheets are tested.

Specimen Thickness Limits for Low-Carbon Steel and Ingot Iron—Test Specimens Prepared by Rolling and Heat Treatment

In a recent effort to obtain more information on limiting thicknesses for testing low-carbon steel and ingot iron sheets, several series of test specimens of various thicknesses were prepared by rolling and heat-treating procedures designed to give uniform hardness (4). No special testing was done to check the uniformity of hardness. The Rockwell 30T tests, however, indicated that the uniformity was quite good for materials in this hardness range.

The results of this investigation are summarized in Fig. 2, and several lines defining limiting thicknesses are shown. In order to show all the original data on a single graph, the data curves were arbitrarily divided into two sets. In an effort to reduce the complexity of this graph the data points themselves were not indicated, but the points were connected by solid straight lines. Nine sample thicknesses were tested in each series. The various limiting thickness lines are the heavier weight, steep-sloping lines. The numbers in the circles are thickness-penetration (T/P) ratios for points on the lines adjacent to the circles.

A steel spot anvil was used for all tests except for the diamond spot anvil tests so labeled.

In Fig. 2 the ordinate is given in both Rockwell numbers and depth of penetration. The depth of penetration was calculated from the Rockwell number by the relationships:

$$\text{Depth of penetration in inches} = (130 - R_B \text{ or } R_F) \times 0.00008$$

$$\text{Depth of penetration in inches} = (100 - R_{30T}) \times 0.00004$$

Since the Rockwell numbers are determined from the dial reading, the depth of penetration as calculated is that produced by the major load less that produced by the minor load. The total penetration is greater than that plotted in Fig. 2 by the depth of penetration of the minor load.

The data plotted as broken lines were check tests at two laboratories on the same series of test specimens. The lower readings were obtained at the Wilson Mechanical Instrument Division of the American Chain and Cable Co. The differences between the Wilson and Armco data are believed to reflect a difference in testing procedure between the two laboratories. In the Armco tests the major load was removed as soon as the trip lever came to rest. In the Wilson tests the major load was removed when the dial indicator came to rest. This can account for several points lower reading in Rockwell B tests of these materials.

In nearly all tests plotted as solid lines in Fig. 2 the hardness increased as the specimen thickness decreased. The thickness at which a break occurred in the hardness-thickness curve was determined for each series. In cases where the increase in hardness was gradual, an increase of one number from the average of the thicker materials was used to determine the limiting thickness. These limiting thicknesses were plotted against the average hardness reading of the heavier gage specimens of each series, and a single average line was drawn for each hardness scale. These are represented as the double ruled lines of Fig. 2. (The broken line test data were not included in these averages.)

It will be noted that the T/P ratios for these double ruled limiting thickness lines are of the order of 7 for the B range, 9 for the F range, and 11 for the 30T range. For comparison, lines representing constant T/P ratios of 7 and 10 are shown as heavy broken lines. These ratios, 7 and 10, are the arbitrary ratios which have been used most often in calculating tables of limiting thickness of hardness test specimens.

Another criterion for determining limiting thickness, suggested by H. LaTour of the Armco Laboratories, is shown as the heavy solid curved line (the steepest line on the graph). This line is based on the assumption that the diameter of the indentation is equal to the thickness of the sheet when anvil effect becomes apparent. The diameter of the indentation was calculated from the depth of penetration (from the Rockwell number), adding the depth of penetration due to minor load. The T/P ratios for such a curved line vary from about 5 to 13. The line approximates the data much better than the lines for constant values of T/P. It is slightly more conservative for Rockwell B and F tests (by about 0.006 in. thickness) than Kenyon's line for polished specimens (see Fig. 1).

The geometry of the indenter and of the specimen for three data points on LaTour's line (A, B, and C in Fig. 2) is represented by scaled diagrams in Fig. 3. (Data point C is slightly to the right of the line in Fig. 2.) Each diagram represents the minimum thickness which can be tested without objection-

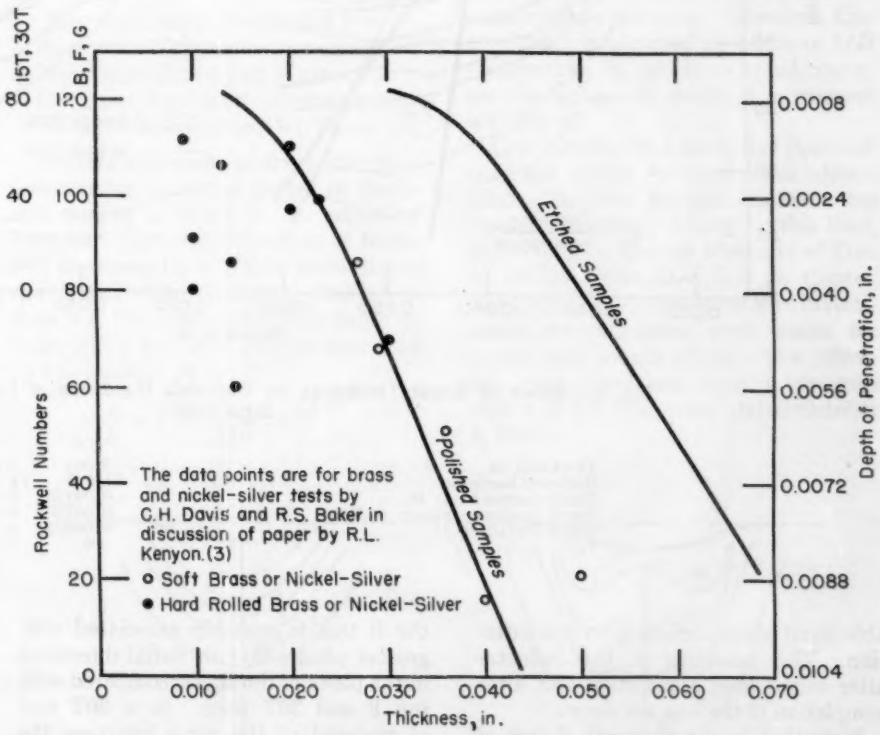


Fig. 1.—Minimum Specimen Thickness for Rockwell Hardness Indentations in Low-Carbon Steel Sheets.

As judged by a difference of two Rockwell numbers from the hardness reading on the thickest specimen tested (solid lines) R. L. Kenyon (3). (Also included are data points for brass and nickel-silver in the soft and hard rolled conditions.)

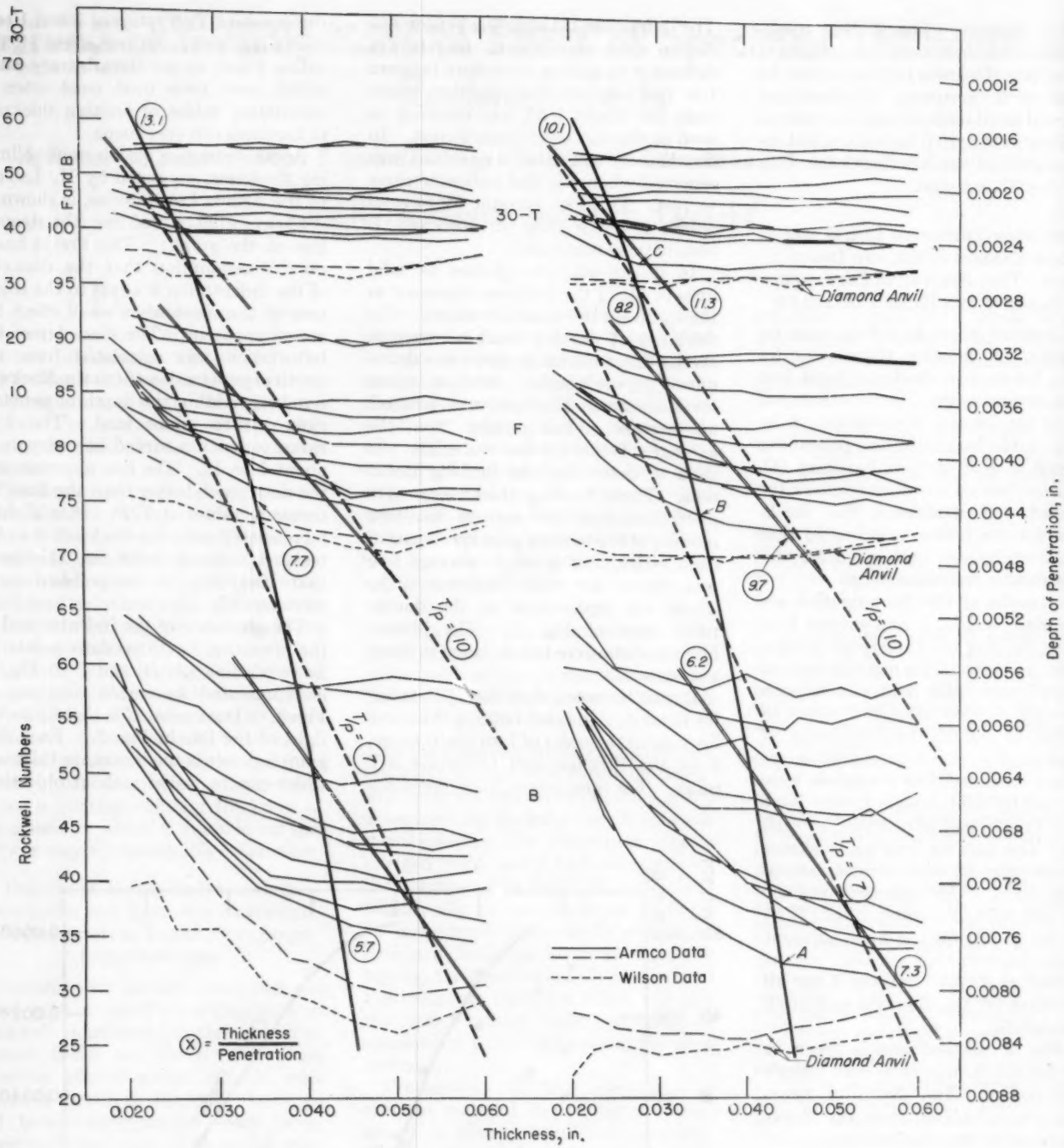


Fig. 2.—Effect of Sheet Thickness on Rockwell Hardness of Low-Carbon Steel and Ingot Iron.

	(a)	(b)	(c)
Thickness, in.	0.044	0.034	0.028
Rockwell hardness	32.5 B	74.5 F	35.0 30T
Depth (minor load), in.	0.00122	0.00124	0.00037
Depth (major − minor) = P, in.	0.00780	0.00444	0.00260
Depth (total), in.	0.00902	0.00568	0.00297
T/P	5.6	7.7	10.8

able anvil effect according to this criterion. The positions of the indenter after minor load application and after completion of the test are shown.

Note that in the Rockwell B test of Fig. 3(*a*) the indenter has pentrated the sample relatively deeply, as indicated by the low T/P ratio. The relatively deep penetration without anvil effect in the B test is probably associated with greater plastic flow in radial directions in the plane of the sheet, compared with the F and 30T tests. In a 30T test of material of the same hardness the indenter makes a relatively shallow indentation and there is less tendency toward lateral plastic flow. When thinner specimens are tested the tendency toward lateral flow offsets the direct anvil effect to a greater extent in the case of the heavy load B test than in the F or 30T test. This is accentuated when the friction between the anvil and the bottom of the specimen is reduced, as in the case of a highly polished hardened steel anvil, or a polished carbide or diamond anvil. The net re-

sult is a lower T/P ratio for the B test than for the F and 30T tests.

Influence of Plastic Flow Under the Indenter on Limiting Specimen Thickness in Rockwell Tests Using Spherical Indenters

In connection with investigations of Brinell testing by R. H. Heyer (5) it was found that the nature of the plastic flow around a spherical indenter was dependent upon the degree of strain or work hardening of the test material prior to test.

It appeared from these tests that the ratio of depth of plastic deformation under the indenter to diameter of indentation of the test material varied with the degree of prior work hardening of the material. Note in Fig. 4 that for a given diameter of Brinell indentation, the depth of plastic deformation of a cold-worked copper alloy was considerably less than that observed in the same alloy in the annealed condition. This was also true of several other materials compared in the cold-worked and annealed conditions. It is also evident in Fig. 4 that the depth of penetration of the indenter below the original surface is less for the cold-worked material than for the annealed, for a given diameter of indentation.

In Rockwell testing with ball indenters, these same indentation and plastic-flow characteristics probably apply; however, in the absence of numerical data it is a matter of speculation whether the ratio of depth of plastic deformation under the indenter to depth of penetration varies with the degree of cold work prior to testing. If there is a change in this ratio, it is likely that the ratio of permissible minimum specimen thickness to penetration will also change with the degree of prior cold work. The only pertinent data about which we are aware are those of C. H. Davis and R. S. Baker, presented in discussion of R. L. Kenyon's paper (3). These data on brass and nickel-silver sheets (Fig. 1) indicate that the soft-annealed materials can be tested in the same thicknesses as Kenyon's polished steels, while many of the cold-rolled materials can be tested in considerably thinner sections without excessive anvil effect. The non-ferrous specimens were reduced to various thicknesses by etching. The results were originally reported as Rockwell hardness *versus* thickness of specimen. The points plotted as minimum specimen thickness in Fig. 1 are based on a difference of two Rockwell numbers from the hardness reading of the thickest specimen tested, as determined by the authors from the published data of Davis and Baker.

To summarize, in making hardness

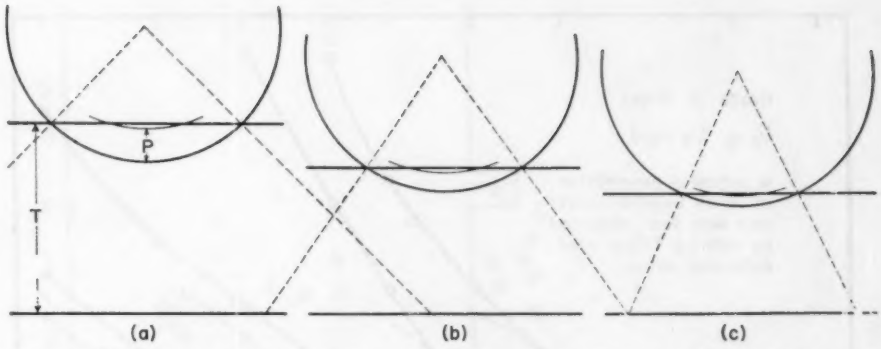


Fig. 3.—Diagrams of Rockwell Indentations in Ingot Iron Sheets of Three Thicknesses Heat Treated to Approximately the Same Hardness (Normalize 1800 F—Box Anneal 1100 F).

The thicknesses selected are the minimum for testing without significant anvil effect. See data points A, B, and C in the right-hand plot of Fig. 2.

indentations with ball type indenters, the manner in which the specimen is plastically deformed in the test is somewhat dependent on the degree of prior work hardening of the metal. For a given size indentation, the depth to which plastic deformation occurs in the hardness test depends on the metallurgical history of the material, soft-annealed materials deforming to greater depths than cold-worked. Hence it is likely that the permissible ratio of sheet thickness to depth of penetration, T/P, should be varied accordingly for most accurate results. Insufficient data are available to confirm this for Rockwell tests.

Limiting Sheet Thickness for Rockwell Tests with Spherical Indenters Using the Method of Peek and Ingerson—Committee B-5, Subcommittee G-1 Tests

Another approach to the problem of determining thickness ranges in Rockwell testing is found in the report of Peek and Ingerson, "Analysis of Rockwell Hardness Data" (6) in which it was shown that when h/D is small, that is, less than 0.1, the relation between depth of indentation and load can be expressed by the formula (6, Eq 4):

$$\frac{h}{D} = \left(\frac{C(W - W_o)}{SD^2}\right)^{1/m}$$

where:

h = depth of indentation from minor to major load in cm,
D = diameter of ball, cm,
W = major load, kg,
Wo = minor load, kg,
S = constant of material having dimensions of a stress, and
C, m = dimensionless constants.

According to Peek and Ingerson: "The divergence from Eq. 4 at high values of h/D presumably represents the effect of thickness proper—that is, the anvil effect, or the effect on apparent hardness of a thickness too small for the strain to become negligible at the lower surface of the specimen. However, this divergence is confined to values of h/D greater than $\frac{1}{10}$, which, as noted above, are throughout in doubtful agreement with Eq 4."

It follows that the method of Peek and Ingerson might be useful for determining limiting sample thickness for Rockwell testing. Following this lead, Subcommittee G-1 on Methods of Test of ASTM Committee B-5 on Copper and Copper Alloys undertook an investigation to determine such limits for copper and copper alloys. The following statements are from a progress report of the task group dated October 4, 1949:

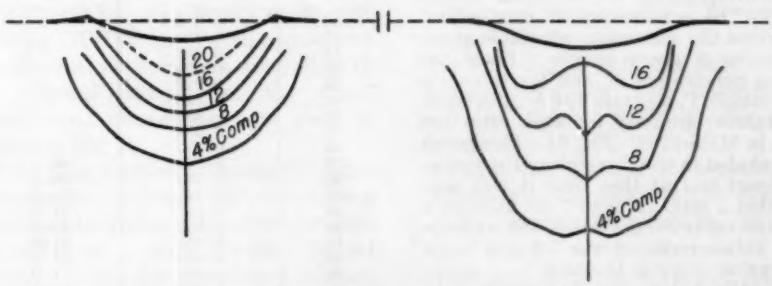
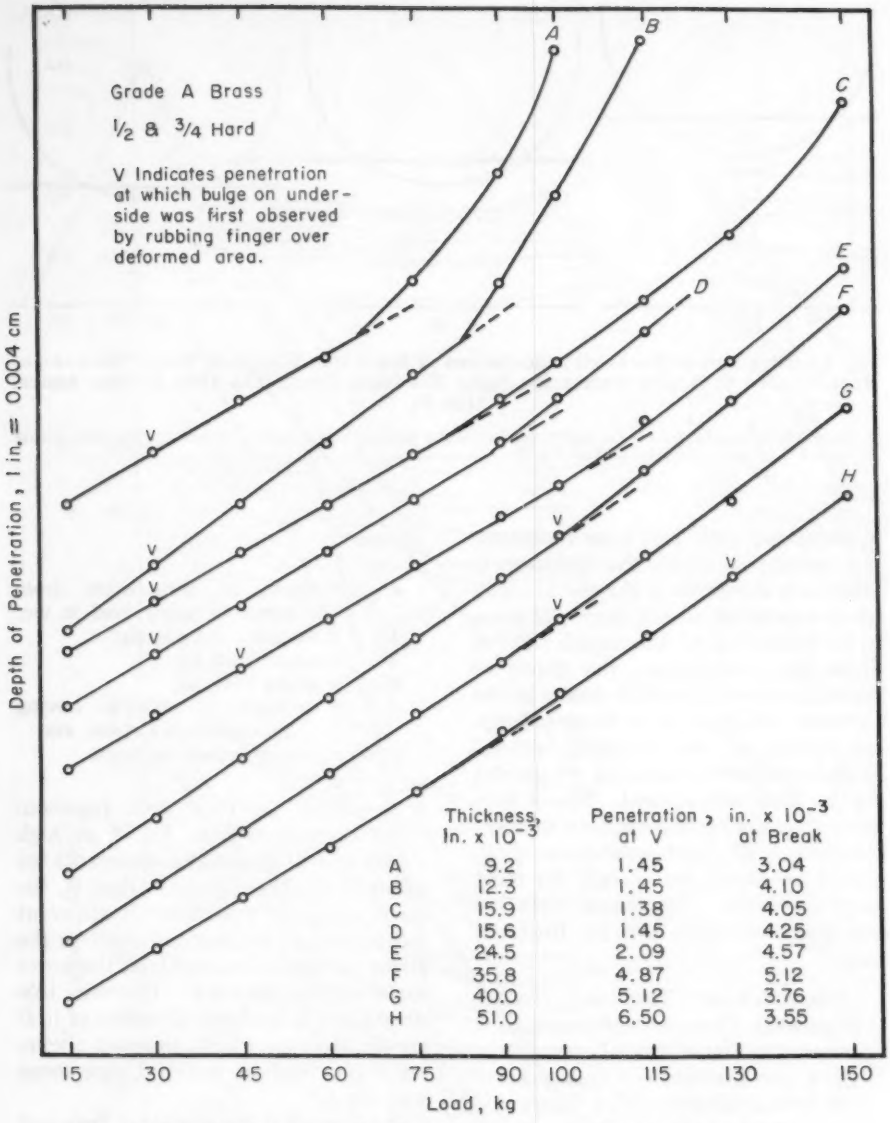


Fig. 4.—Permanent Compression Strains Under 5.0-mm Diameter Brinell Indentations in Silicon Bronze.



	Thickness, In. x 10^{-3}	Penetration, in. x 10^{-3} at V	at Break
A	9.2	1.45	3.04
B	12.3	1.45	4.10
C	15.9	1.38	4.05
D	15.6	1.45	4.25
E	24.5	2.09	4.57
F	35.8	4.87	5.12
G	40.0	5.12	3.76
H	51.0	6.50	3.55

Fig. 5.—Penetration *versus* Load—Grade A Brass—Western Electric Data.

"This method consists of taking a series of Rockwell hardness readings at increasing loads, calculating from these hardness values the depth of penetration of the $\frac{1}{16}$-in. diameter ball and plotting these penetrations against the major load as shown in MES-13779 [Fig. 5]. It is assumed that for a given sample the hardness values obtained by the different loads or scales is free of anvil effect so long as the graph is linear, and that the load at which the anvil effect first becomes significant is that corresponding to the break in the graph. The penetration at this critical load gives the maximum allowable penetration for a given sample. From the limiting penetration P, and the thickness of the sample T, the ratio T/P is calculated. The values obtained for this ratio are shown in MES-12963 [Fig. 6]. This graph was included in the November, 1948 progress report and at that time it was sugested that a ratio value of 7 be used on a tentative basis even though the average of the values reported was 5.2 and many of the values were as low as 4."

"On MES-13779 [Fig. 5] there is indicated by a V, the load and penetration D, at which a bulge was first noted on the underside by rubbing the finger over the deformed area. On the thinner samples the bulge effect occurred at loads less than that corresponding to the break in the graph. For all samples on which bulge information was available the values for the ratio, T/D, of the sample thickness to penetration for bulge as described, have been calculated and are plotted on MES-13778 [Fig. 7]. The wide spread of these results is comparable to the spread of the T/P results of MES-12963 [Fig. 6], and thus indicates the effect of differences between the materials tested. However, it is probable that much of the spread in the T/D results is due to the qualitative nature of the finger test for the bulge and that a part of the T/P results is due to the difficulty of determining the point where the graph departs from linearity.

"From MES-13779 [Fig. 5], according to the above-described method, it follows that with 0.012-in. thick Grade A brass, satisfactory hardness readings can be obtained using loads as high as 80 kg. Because of the probable damage to the ball or the anvil if thin sheet is tested regularly with loads as high as permitted by the break in the respective graphs, it is now felt that the results of this method should be adjusted for sheet 0.025 in. or less in thickness so as to give weight to the bulge effect and the resulting care of the hardness machine. This consideration forms a reasonable basis for using a conservative value of 7 for the ratio T/P instead of a value nearer to the ratio average of 5.2. Other investigations also have concluded that a T/P ratio of 7 is a satisfactory guide for making regular hardness tests on thin sheet metal. On the basis of a ratio value of 7, the minimum thicknesses of stock for the different Rockwell scales has been calculated and are listed in Table I. It is recommended that these values be adopted for use in B-5 specifications, as required."

However, when such values were studied by the operating departments of various mills, it was felt that they differed too much from current accepted practice to adopt them.

Limiting Thickness for Tests with Spherical Indenters Using the the Method of Peek and Ingerson—Committee E-1, Subcommittee 6 Tests

The test method of Peek and Ingerson was applied to brass, aluminum alloy, and ingot iron test specimens with results as shown in Fig. 8. A standard hardened steel spot anvil was used. The test on thin brass confirms the departure from linearity reported by Peek

TABLE I.—RECOMMENDED MINIMUM THICKNESS OF STOCK FOR ROCKWELL B, F AND 30T SCALE TESTS OF BRASS, BRONZE, AND NICKEL SILVER SHEET.

Scale B	Minimum Thickness, in.	Scale F	Minimum Thickness, in.	Scale 30T	Minimum Thickness, in.
100	0.018			82.0	0.006
97	0.020			80.5	0.006
94	0.022			78.5	0.007
91	0.024			77.0	0.007
88	0.026			75.0	0.008
85	0.028			73.5	0.008
82	0.030			71.5	0.009
79	0.031			69.5	0.009
76	0.033			67.5	0.010
72	0.036	98.0	0.021	65.0	0.011
66	0.039	94.5	0.023	60.5	0.012
60	0.043	91.0	0.026	56.5	0.013
54	0.047	87.5	0.028	52.5	0.015
48	0.050	84.5	0.030	48.5	0.016
42	0.054	81.0	0.032	44.0	0.017
36	0.058	77.5	0.035	40.0	0.018
30	0.061	74.0	0.037	36.0	0.020
20	0.068	68.5	0.041	29.0	0.022
8	0.075	61.5	0.046	20.5	0.024
0	0.080	57.0	0.048	15.0	0.026

and Ingerson for tests on Grade B nickel silver and on soft brass, and the tests on brass, bronze, and nickel silver by Subcommittee W-1 on Plate, Sheets and Strip of Committee B-5. In the case of 24S-T aluminum alloy and some of the ingot iron tests, no departure from linearity occurred even in tests at very low ratios of T/P in which objectionable "punching through" was noted. In some instances in which the 150-kg load was used on soft materials it appeared that the screw cap of the ball indenter contacted the surface of the sample, giving erratic readings. These points are connected to the 130-kg points with dash lines in Fig. 3.

As a further check on the significance of the breaks in the load-penetration lines, the data for the breaks in Fig. 5 were plotted to thickness-penetration coordinates in the same manner as in Fig. 2. Although the number of points is small, the data made a random pattern, not conforming to any criterion of limiting thickness. It should be noted, however, that these data represent several compositions and tempers; hence this result is probably to be expected.

Following the tests on brass, aluminum alloy, and ingot iron by Subcommittee 6 on Indentation Hardness of Committee E-1 on Methods of Testing, a further communication was received from Subcommittee W-1 of ASTM Committee B-5 on Copper and Copper Alloys dated May 9, 1951, showing tests on three sheets of stainless steel. A test was then made on ¼ hard Type 301 stainless steel and a break was noted at 90-kg load as shown in Fig. 8. In a test of Type 302 of about the same thickness (0.0075 in.) and hardness, the data of Subcommittee W-1 showed a break at 130 kg.

After studying these data the Subcommittee 6 Task Group on Minimum Thickness of Material in Rockwell Testing concluded that the method based on multiple load tests has not been sufficiently developed and proved for general use in establishing limiting thicknesses of hardness test pieces.

Limiting Sheet Thickness for Rockwell Tests on Hardened Steels, Using the Brale Indenter

In 1941 an investigation was made at Armco Research Laboratories to determine minimum sample thickness limits for heat-treated steel. A 0.080-in. thick sheet of annealed SAE 4130 steel was cold rolled to 10 different thicknesses down to 0.0125 in., annealed, pickled, heated 10 min at 1540 F in a salt bath, quenched in 5 per cent brine solution, tempered to 4 hardness levels, pickled, and polished on both surfaces by hand through 00 paper. Precautions were taken to prevent decarburization in all heat treatments. Test results for five Rockwell and Superficial Rockwell scales are shown in Fig. 9. (The C scale tests on the softest samples are not shown because they were under 20 Rockwell C.)

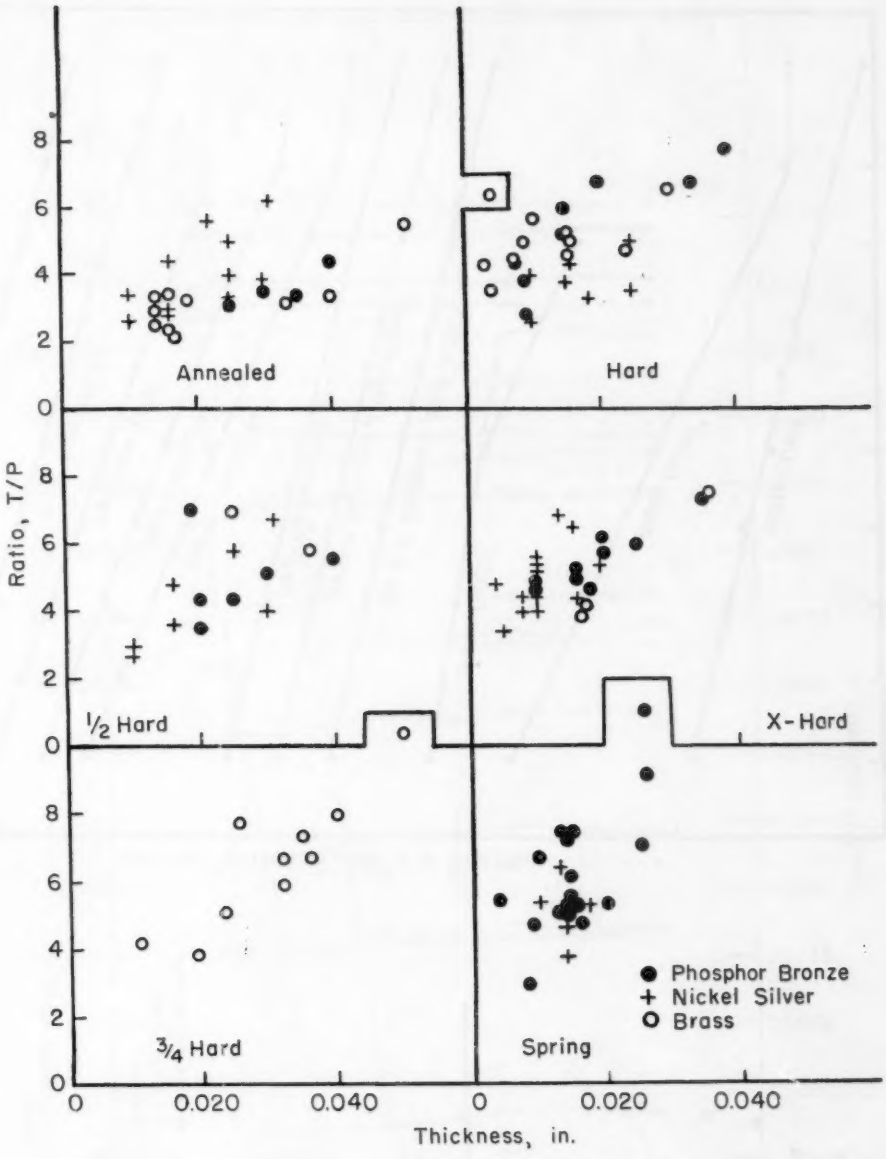


Fig. 6.—Ratio T/P versus Thickness for Different Tempers of Brass, Bronze, and Nickel Silver—Western Electric Data.

The uniformity of hardness of specimens at each hardness level was checked by 30-kg DPH tests. Small corrections for differences in hardness were made in the original analysis of the data; however, no corrections were used in preparing Fig. 9.

While Fig. 9 shows a tendency for the hardness to decrease with decreasing specimen thickness, with a fairly abrupt drop-off in some cases, the data did not appear suitable for selecting minimum thickness limits.

A similar but more extensive investigation at Wilson Mechanical Instrument Division resulted in the thickness limits reported in Figs. 84 and 85 in "Indentation Hardness Testing" (7). These limits are shown in Fig. 9 as the solid steeply sloping curved lines.

The original Wilson data lines (not reproduced here) show, in general, sharper breaks than the Armco data. However, Fig. 9 indicates that the two investigations are not incompatible, and the Wilson limits appear to be satisfactory.

Using the method of equating the indentation diameter to the thickness of the specimen, the broken line limits of Fig. 9 were calculated. These limits are less conservative than the Wilson limits and are not considered to be satisfactory by the authors.

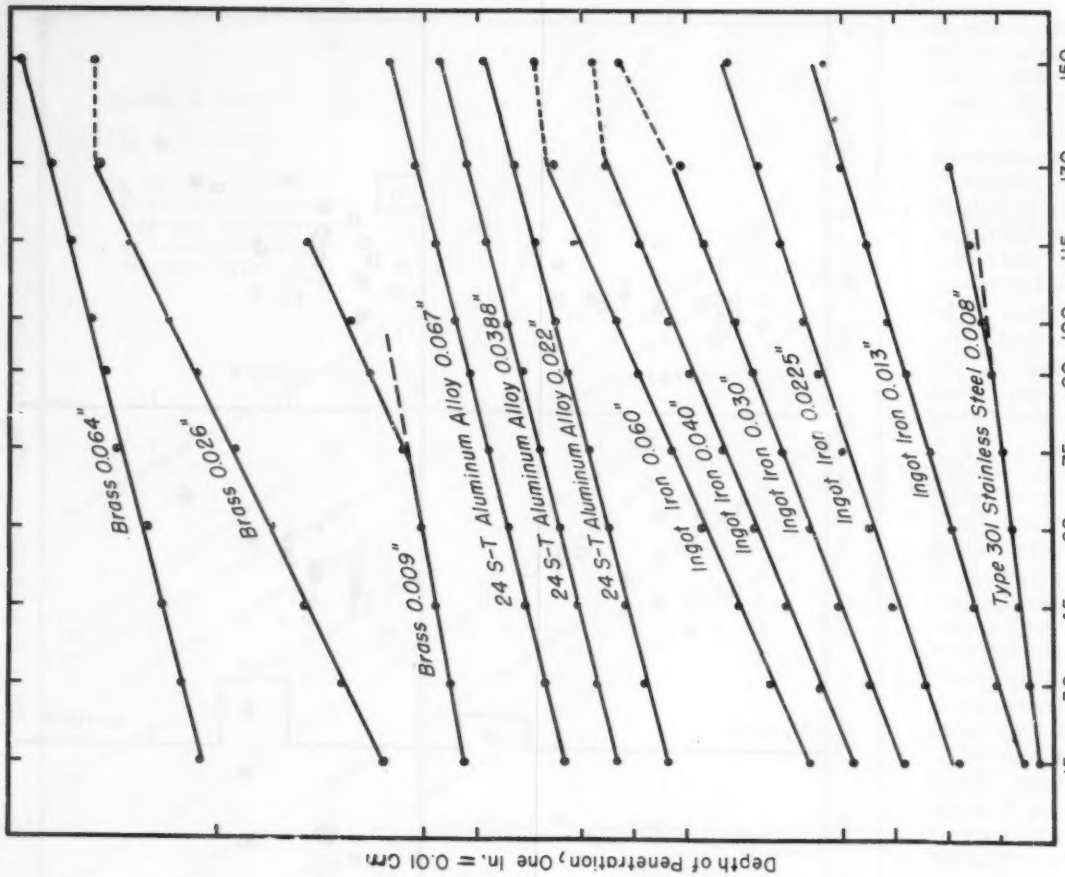


Fig. 8.—Penetration versus Load—Peek and Ingerson Method—Armco Data.

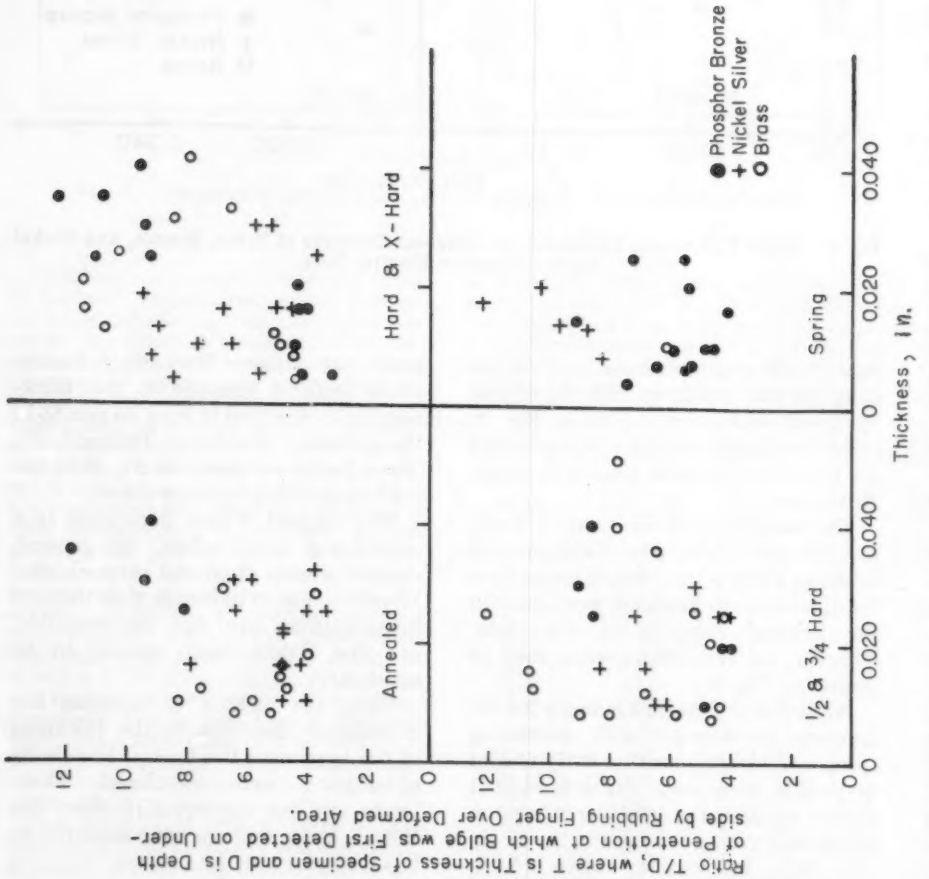


Fig. 7.—Ratio T/P versus Thickness for Different Tempers of Brass, Bronze, and Nickel Silver—Western Electric Data.

In general the T/P ratios for the Wilson limits are higher than the corresponding ratios of Fig. 2 for ball indenters, especially in the superficial ranges. The explanation offered for the lower T/P ratios at the deeper penetrations with the ball indenter (see Fig. 2) does not appear to be applicable to tests with the Brale indenter because of the geometrical similarity of indentations made with the Brale.

Furthermore, in tests with the Brale indenter the anvil effect is evidenced by lower readings, rather than higher readings as in the case of the ball indenter tests on soft steels reported in Fig. 2. It should be pointed out that Kenyon's tests on soft steels also showed an initial reduction in readings followed by an increase as the thickness of the samples was further reduced (Fig. 2 (3)).

It can be concluded that "anvil effect" can produce apparent hardening or softening, and on occasion the various factors which control the plastic deformation of the metal in a Rockwell test can be fully compensating, resulting in apparently accurate hardness numbers for samples thinner than normally considered safe for testing.

Pratt & Whitney Hardness Scale Selector for Steel

E. F. Bradley of Pratt & Whitney Aircraft Division, United Aircraft Corp., has recently published a chart for selecting a suitable hardness scale for different thicknesses of material (8). Thickness limits are given for Brinell, Rockwell, and Vickers (DPH) tests. This chart is based on a ratio of T/P of 10, using total depth of penetration including minor load. Referring to the T/P values on the Wilson thickness limits of Fig. 9, it will be noted that the Pratt & Whitney limits are less conservative for the Superficial Rockwell tests and more conservative for the Rockwell C tests.

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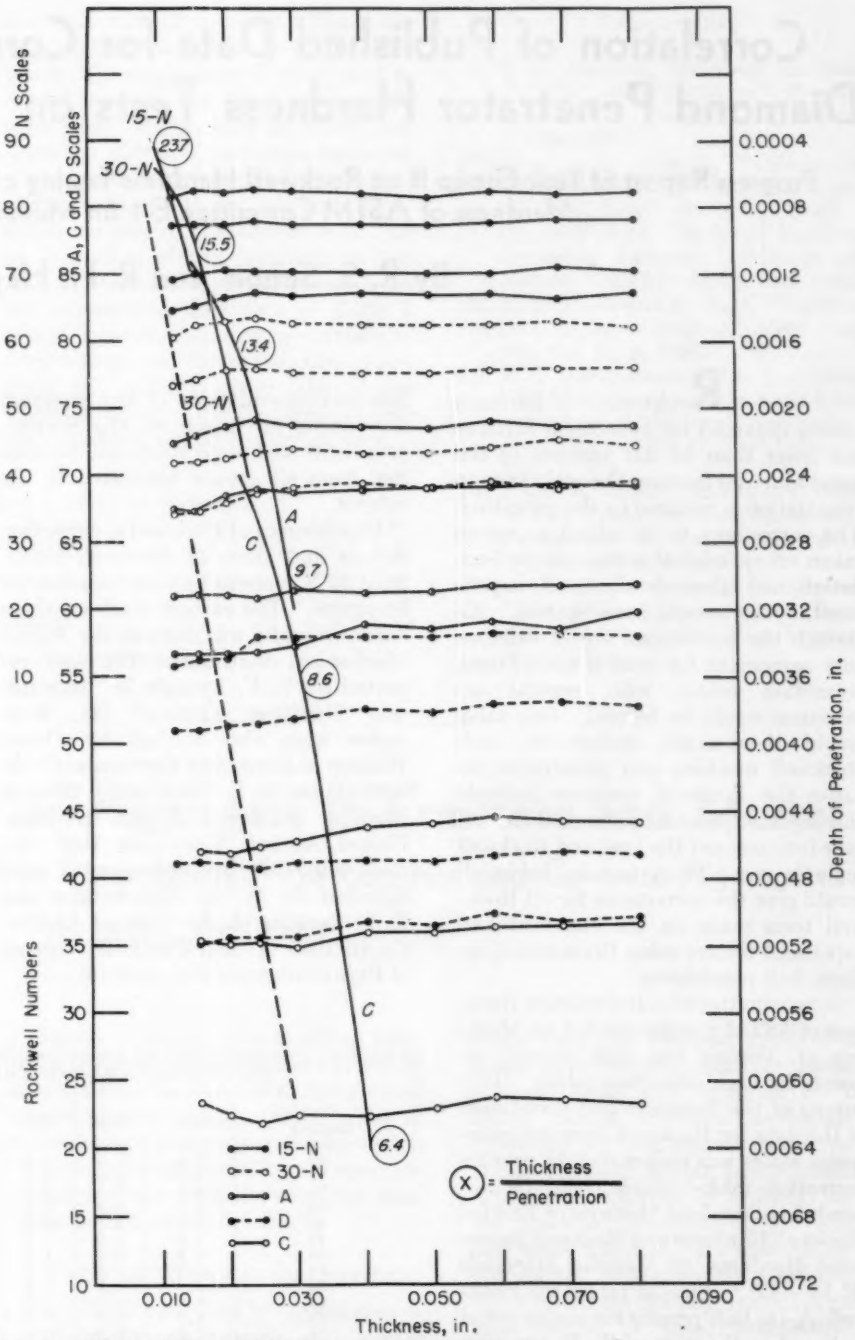

Fig. 9.—Effect of Sheet Thickness on Rockwell Hardness of SAE 4130 Steel Quenched and Tempered.

References

(1) H. M. Van Deusen, L. I. Shaw, and C. H. Davis, "Physical Properties and Methods of Test for Sheet Brass," *Proceedings*, Am. Soc. Testing Mats. Vol. 27, Part II, p. 173 (1927).

(2) J. R. Townsend, W. A. Straw, and C. H. Davis, "Physical Properties and Methods of Test for Some Sheet Non-Ferrous Metals," *Proceedings*, Am. Soc. Testing Mats. Vol. 29, Part II, p. 381 (1929).

(3) R. L. Kenyon, "Effect of Thickness on the Accuracy of Rockwell Hardness Tests on Thin Sheets," *Proceedings*, Am. Soc. Testing Mats. Vol. 34, Part II, p. 229 (1934).

(4) G. D. Miller and R. H. Heyer, "Effect of Surface and Thickness on Rockwell Hardness Testing of Sheet Steel," Unpublished report, Armco Research Laboratories.

(5) R. H. Heyer, "Analysis of Brinell Hardness Test," *Proceedings*, Am. Soc. Testing Mats. Vol. 37, Part II, p. 119 (1937).

(6) R. L. Peek, Jr., and W. E. Ingerson, "Analysis of Rockwell Hardness Data," *Proceedings*, Am. Soc. Testing mats. Vol. 39, p. 1270 (1939).

(7) Vincent E. Lysaght, "Indentation Hardness Testing," Reinhold Publishing Corp., New York, N. Y. (1949).

(8) Pratt & Whitney Aircraft, "Data Sheet—Hardness Scale Selector for Steel," *Metal Progress*, Vol. 60, p. 80B (1951).

Correlation of Published Data for Correction of Rockwell Diamond Penetrator Hardness Tests on Cylindrical Specimens

Progress Report of Task Group II on Rockwell Hardness Testing of Subcommittee 6 on Indentation Hardness of ASTM Committee E-1 on Methods of Testing

By R. S. Sutton[1] and R. H. Heyer[2]

ROCKWELL hardness values obtained on cylindrical surfaces are lower than on flat surfaces of the same material because the resistance to penetration is reduced by the curvature. The corrections to be added to values taken on cylindrical surfaces have been determined theoretically and experimentally by several investigators. Although the corrections are in satisfactory agreement for most practical uses, correction tables with general acceptance would be helpful. One table would theoretically suffice for each Rockwell machine and penetrator because the Rockwell numbers indicate the depth of penetration and, therefore, take into account the load and Rockwell scale in use. Thus, four tables in all would give the corrections for all Rockwell tests made on the standard and superficial testers using Brale and $\frac{1}{16}$ in. diam. ball penetrators.

Subcommittee 6 on Indentation Hardness of ASTM Committee E-1 on Methods of Testing has had several requests for such correction tables. This survey of the literature and correlation of the data for Rockwell diamond penetrator scales was undertaken to provide correction tables which could be appended to Standard Methods of Test for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials (E 18 – 42).[3] Similar tables for Rockwell $\frac{1}{16}$-in. ball penetrator scales could be based on the work of W. E. Ingerson (1),[4] V. E. Lysaght (2), and David Wallace (3).

Undoubtedly there are many correction curves, nomographs, and tables in use in various plants which have not been published. The conclusions reached in this summary are based on published material only. However, before recommendations of any standard corrections are made to the Society, comments and suggestions will be solicited from all groups interested in the subject.

Five sources of Rockwell C correction factors and three of Rockwell superficial 30 N corrections were found in the literature. The earliest work on these hardness scales was done at the Wilson Mechanical Instrument Co. and reported by V. E. Lysaght in "Indentation Hardness Testing" (2). Both scales were also studied by David Wallace of the Sperry Gyroscope Co. in 1946 (3) and G. E. Poole and J. Hunt of Pratt & Whitney Aircraft Division, United Aircraft Corp., in 1947 (4). Rockwell C corrections only were obtained by W. L. Fleischmann and R. S. Jenkins of the General Electric Co. in 1945 (5) and Frank W. Hussey of Frankford Arsenal in 1950 (6).

In 1952 Louis Small and Keith Symon of the Service Diamond Tool Co. published correction tables for the $\frac{1}{16}$ in. ball and diamond penetrator scales, both regular and superficial (7). Their values were presumably derived mathematically because they agree exactly with the values calculated by Lysaght (2).

An attempt was made to explain the differences between some of the corrections by investigating the procedures used. However, all the work appeared to have been conducted carefully to avoid the effects of decarburization and of hardening or tempering by grinding. Other test variables such as type of material, Rockwell machine errors, type of anvil, and operator errors would tend to cancel since the reported corrections are the differences between Rockwell readings on flat and cylindrical surfaces. Therefore, the summary corrections

TABLE I.—CORRECTIONS TO BE ADDED TO ROCKWELL C, A, AND D VALUES OBTAINED ON CYLINDRICAL SPECIMENS OF VARIOUS DIAMETERS.

Dial Reading	¼ in.	⅜ in.	½ in.	⅝ in.	¾ in.	⅞ in.	1 in.	1¼ in.	1½ in.
20	6.0	4.5	3.5	2.5	2.0	1.5	1.5	1.0	1.0
25	5.5	4.0	3.0	2.5	2.0	1.5	1.0	1.0	1.0
30	5.0	3.5	2.5	2.0	1.5	1.5	1.0	1.0	0.5
35	4.0	3.0	2.0	1.5	1.5	1.0	1.0	0.5	0.5
40	3.5	2.5	2.0	1.5	1.0	1.0	1.0	0.5	0.5
45	3.0	2.0	1.5	1.0	1.0	1.0	0.5	0.5	0.5
50	2.5	2.0	1.5	1.0	1.0	0.5	0.5	0.5	0.5
55	2.0	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0
60	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0	0
65	1.5	1.0	1.0	0.5	0.5	0.5	0.5	0	0
70	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0	0
75	1.0	0.5	0.5	0.5	0.5	0.5	0	0	0
80	0.5	0.5	0.5	0.5	0.5	0	0	0	0
85	0.5	0.5	0.5	0	0	0	0	0	0
90	0.5	0	0	0	0	0	0	0	0

TABLE II.—CORRECTIONS TO BE ADDED TO ROCKWELL 15 N, 30 N, AND 45 N VALUES OBTAINED ON CYLINDRICAL SPECIMENS OF VARIOUS DIAMETERS.

Dial Reading	⅛ in.	¼ in.	⅜ in.	½ in.	¾ in.	1 in.
20	6.0	3.0	2.0	1.5	1.5	1.5
25	5.5	3.0	2.0	1.5	1.5	1.0
30	5.5	3.0	2.0	1.5	1.0	1.0
35	5.0	2.5	2.0	1.5	1.0	1.0
40	4.5	2.5	1.5	1.5	1.0	1.0
45	4.0	2.0	1.5	1.0	1.0	1.0
50	3.5	2.0	1.5	1.0	1.0	0.5
55	3.5	2.0	1.5	1.0	0.5	0.5
60	3.0	1.5	1.0	1.0	0.5	0.5
65	2.5	1.5	1.0	0.5	0.5	0.5
70	2.0	1.0	1.0	0.5	0.5	0.5
75	1.5	1.0	0.5	0.5	0.5	0
80	1.0	0.5	0.5	0.5	0	0
85	0.5	0.5	0.5	0.5	0	0
90	0	0	0	0	0	0

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[3] 1952 Book of ASTM Standards, Part 2, p. 1238.

[4] The boldface numbers in parentheses refer to the list of references appended to the paper.

given below were obtained by averaging the corrections found by all the investigators and adjusting the averages slightly to give a smooth relationship between the corrections at the various hardness levels and specimen diameters.

In tabulating the results, the minimum hardness unit was taken as a half-point Rockwell. The hardness levels selected were five Rockwell numbers apart and the diameters were in $\frac{1}{8}$ and $\frac{1}{4}$-in. intervals to simplify the use of the tables.

The table based on C scale hardness values applies theoretically to the A and D scales also, and the table based on 30 N corrections applies equally well to the 15 N and 45 N scales. There are few experimental data to check this; however, a comparison of the C and A corrections and the 30 N and 45 N corrections in the work of Poole and Hunt (4) shows a maximum variation of one point Rockwell.

The work sheets for this correlation are in the files of Subcommittee 6. As an indication of the variations in the data of the various investigations from the adjusted average data of Table I and II, the following average deviations were determined for the smaller diameters of cylinders over the entire hardness ranges. For the large cylinder diameters the deviations are smaller.

Rockwell C for $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, and $\frac{5}{8}$ in. Cylinders.

Reference	(2)	(3)	(4)	(5)	(6)
Average deviation in Rockwell numbers from Table I	−0.3	−0.6	0.1[a]	+0.8	0.2[a]

Rockwell 30 N for $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$, and $\frac{1}{2}$ in. Cylinders.

Reference	(2)	(3)	(4)
Average deviation in Rockwell numbers from Table II	−0.2	+0.5	0.2[a]

[a] Average taken regardless of sign because deviations are both positive and negative.

References

(1) W. E. Ingerson, "Rockwell Hardness of Cylindrical Specimens," *Proceedings*, Am. Soc. Testing Mats., Vol. 39, p. 1281 (1939).

(2) Vincent E. Lysaght, "Indentation Hardness Testing," Reinhold Publishing Corp., New York, N. Y. (1949).

(3) David Wallace, "Rockwell Hardness Correction Factors," *Materials and Methods*, Vol. 23, February, 1946, p. 473.

(4) G. E. Poole and J. Hunt, "Hardness Corrections for Rounds," *Metal Progress*, Vol. 51, p. 776-B (1947).

(5) W. L. Fleischmann and R. S. Jenkins, "Rockwell Hardness (Diamond Penetrator) of Cylindrical Specimens," *Metal Progress*, Vol. 47, No. 2, February, 1945, p. 275.

(6) Frank W. Hussey, "Rockwell C Hardness on Cylindrical Steel Specimens," *Proceedings*, Am. Soc. Testing Mats., Vol. 50, p. 1176 (1950).

(7) Louis Small and Keith Symon, "Round Work Correction for Rockwell Hardness," *The Tool Engineer*, August, 1952.

Potential Reactivity of Aggregate in Concrete and Mortar

A Report of Subcommittee II-b, Committee C-9 on Concrete and Concrete Aggregates

By Richard C. Mielenz[1]

Subcommittee II-b on Chemical Reactions of Aggregates in Concrete, ASTM Committee C-9 on Concrete and Concrete Aggregates, regards its functions as threefold, namely: (1) establishing and describing the kinds of chemical reactivity of aggregates, (2) developing and describing methods of measuring potential reactivity of aggregates in mortar and concrete, and (3) developing and describing means by which effects of reactivity can be overcome. Abundant investigation has demonstrated that most aggregates are reactive in any of a variety of ways and in degrees ranging from beneficial through innocuous to deleterious. Consequently, to solve a problem of aggregate reactivity, the reactions involved must first be identified and then appropriate tests must be developed to measure the effects of the reaction in terms of strength, durability, volume stability, and other properties of concrete and mortar.

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Effective means of controlling reactivity depend either upon inhibition of the reactions by removal or tying up of one or more substances participating in the reactions, or merely upon production of a physical structure in the concrete or mortar such that the chemical reactions do not cause distress.

Types of Chemical Reactivity

Chemical reactions of aggregates in portland-cement concrete and mortar can be subdivided into two major categories: (1) reactions dependent upon alkalies (sodium and potassium) released during the hydration of portland cement, and (2) reactions not dependent upon alkalies released during the hydration of portland cement.

Reactions Dependent upon Alkalies Released During Hydration of Portland Cement:

The so-called alkali-aggregate reaction was described first by Stanton (1)[2] in 1940 as the result of experience in California. Great volumes of work reported elsewhere demonstrate conclusively that this reaction involves the attack upon certain relatively unstable siliceous rocks and minerals by the highly caustic solutions developed in hydrating portland cement as the result of dissolution of sodium and potassium. A high concentration of hydroxyl ion is the essential requirement for alkali-aggregate reaction. By dissolution of sodium and potassium, the alkalinity of the solution permeating hydrating portland cement is raised sufficiently to cause development of silica gels from the substance of susceptible particles of aggregate. Within certain limits of alkali-to-silica ratio, these gels can absorb water and develop osmotic or swelling pressure sufficient to distend or rupture portland-cement concrete or mortar.

Alkali-reactive rocks and minerals are: the silica compounds opal, chalcedony, tridymite, and cristobalite; volcanic glass of rhyolitic, latitic, dacitic, or andesitic composition; certain zeolites, such as heulandite and natrolite; and at least certain phyllites (2).

The alkalies (sodium and potassium) participating in alkali-aggregate reaction originate largely in the portland cement. However, they may also be contributed

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

by aggregate or pozzolanic admixtures, especially those containing soluble salts of sodium or potassium; minerals of moderate or high cation exchange capacity, such as zeolites and expanding lattice clay minerals; or substances containing sodium and potassium rendered water soluble by reaction with caustic solutions developed by hydration of portland cement.

Deleterious alkali-aggregate reactivity in mortar and concrete depends primarily upon the ratio of available alkalies to silica susceptible of dissolution. The alkali-silica ratio correlating with potentiality for hydration and swelling undoubtedly varies with content of other elements, such as aluminum, calcium, and iron. Also, different levels of alkalinity are required to initiate production of hydratable siliceous gel from potentially reactive substances. Consequently, a deleterious degree of reaction can occur with cements containing about 0.2 per cent alkalies, if the aggregate contains only 1 per cent or so of opal, or analogously small proportions of other deleteriously reactive minerals or rocks (**3**, **4**, **5**).

Reactions Not Dependent upon Alkalies Released During Hydration of Portland Cement:

The most important cement-aggregate reaction, other than the alkali-aggregate reaction, involves the highly feldspathic, granitic sand-gravel aggregates of the Republican, Platte, Loup, and Kansas Rivers of Kansas and Nebraska, and also occurring in northwestern Missouri and western Iowa. The cracking and expansion of concrete and mortar associated with this action can be produced by heating and cooling and simultaneous drying and wetting. Extensive studies by Conrow (**6**) demonstrate that the critical conditions of curing and storage conducive to development of adverse expansion are (1) a period of hydration (set of 28 days at 73.4 F in a proposed procedure of test) followed by (2) a hydration period during which the temperature is raised above 75 F (set at 131 F for 7 days in a proposed test). With deleterious cement-aggregate combinations, rapid expansion and cracking result during subsequent storage in water even at constant temperature (set at 73.4 F in a proposed test procedure). The rate and magnitude of expansion can be increased by introduction of a drying period during curing.

Results of the test show no clear-cut relationship to alkali content of the cement. However, alkali-aggregate reaction occurs contemporaneously, although largely independently, if alkali-reactive constituents are present in the aggregate. Nevertheless, great expansion has been obtained on laboratory specimens containing cements whose alkali content is less than 0.2 per cent as Na_2O.

The mechanism by which mortar and concrete containing the sand-gravel aggregate expand and crack as the result of heating and cooling and wetting and drying is not understood. Contributory factors, at least, are the characteristically low thermal coefficient of expansion of the feldspathic aggregate, the poor bonding surface, and the rigidity (low compressibility) of the particles. Conrow postulates that calcium hydroxide released during the hydration of the portland cement plays a critical role in the process.

Other types of reactivity of aggregates are only locally significant (**7**). They include oxidation and hydration occurring during decomposition of the iron sulfides pyrite and marcasite (FeS_2), resulting in the release of sulfuric acid and production of hydrated iron oxides of increased volume. This process is common in warm, humid areas, but is negligible in cold and dry regions. Oxidation and hydration of ferrous and ferric oxides in clay ironstone particles cause expansion which may create pop-outs and initiate deterioration of concrete. Carbonation together with hydration can be significant in aggregates produced from industrial wastes if CaO or MgO originally are present.

Measurement of Effects of Chemical Reactivity of Aggregate

At the request of the chairman of Committee C-9, Subcommittee II-b undertook a study of methods for evaluating chemical reactivity of concrete aggregates. Progress is reported as follows:

1. The Tentative Recommended Practice for Petrographic Examination of Aggregate for Concrete (C 295 – 52 T),[3] developed under the sponsorship of Subcommittee II-f on Aggregate Mineralogical Characteristics and accepted by the Society in 1952, can be recommended as a satisfactory method for identifying potentially reactive constituents of aggregates, provided the examination is performed by an experienced petrographer.

2. The Tentative Method of Test for Potential Reactivity of Aggregates (Chemical Method) (C 289 – 52 T),[4] was developed under the sponsorship of Subcommittee II-b and accepted by the Society in 1952 as a means for establishing potential alkali reactivity of concrete aggregate.

3. The Tentative Method of Test for Potential Alkali Reactivity of Cement-Aggregate Combinations (C 227 - 52 T),[5] developed under the sponsorship of the Working Committee on Volume Change and Soundness of Portland Cement of Committee C-1 on Cement, is recommended by Subcommittee II-b as a means of detecting alkali reactivity of cement-aggregate combinations.

4. A proposed tentative method of test for potential abnormal expansion of cement-aggregate combinations is now being subjected to cooperative tests under the sponsorship of Subcommittee II-b to establish its reproducibility in determining the expansion of concrete beams subjected to alternate wetting and drying with heating and cooling.[6]

5. A proposed tentative method of test for potential volume change of cement-aggregate combinations subjected to variations of temperature and water saturation also is now being subjected to cooperative tests under the sponsorship of Subcommittee II-b to establish its reproducibility in determining expansion of mortar bars subjected to immersion at constant temperature following one cycle of heating to 131 F in water and one cycle of drying at 131 F in air.[6]

The test for potential abnormal expansion was developed by C. H. Scholer (**8**) and the test for potential volume change by A. D. Conrow (**6**), to evaluate the durability of combinations containing the sand-gravel aggregates of Kansas and Nebraska. During the cooperative program the Scholer test caused significant expansion only with combination of high-alkali cement and Republican River sand and gravel (Figs. 1 and 2), although high expansion has been observed in this test in other work with combinations of certain aggregates and low-alkali cements. After 180 cycles, the average expansion ranges from 0.238 to 0.558 per cent. Companion specimens containing Republican River aggregate and low- and medium-alkali cements, or aggregate from Grand Coulee, Wash., or from Clear Creek, near Denver, Colo., in combination with low-, medium-, and high-alkali cements, yielded small contraction or expansion up to only 0.049 per cent.[7]

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[3] 1952 Book of ASTM Standards, Part 3, p. 978.

[4] 1952 Book of ASTM Standards, Part 3, p. 943.

[5] 1952 Book of ASTM Standards, Part 3, p. 44.

[6] See Appendix.

[7] Except for inordinately high expansion obtained by one laboratory on specimens containing Republican River aggregate and cement of medium alkali content (0.58 per cent alkalies, as Na_2O). At 180 cycles the expansion reported by this laboratory is 0.152 per cent in contrast to expansion between −0.002 to 0.040 per cent reported by the other five laboratories for this combination.

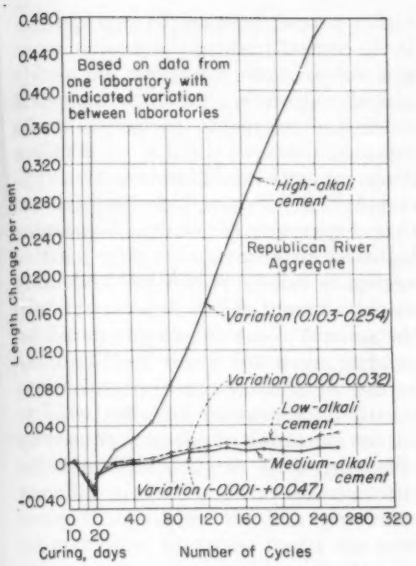

Fig. 1.—Results of Cooperative Tests, Proposed Tentative Method of Test for Potential Abnormal Expansion of Cement-Aggregate Combinations.

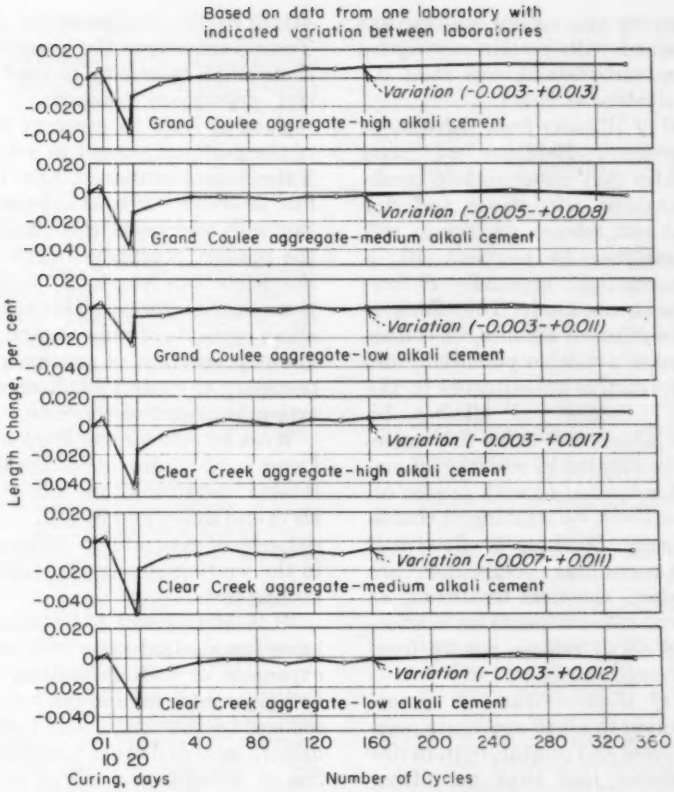

Fig. 2.—Results of Cooperative Tests, Proposed Tentative Method of Test for Potential Abnormal Expansion of Cement-Aggregate Combinations.

In the Conrow test, significant expansion is obtained only with the Republican River aggregate (Fig. 3). Oddly enough, the expansion of bars containing the low-alkali cement and Republican River aggregate exceeds the expansion of bars containing the medium- and high-alkali cements and that aggregate, the average expansion of bars containing low-alkali cement being 0.255 per cent and that of the high-alkali cement bars being 0.226 per cent at an age of 268 days. As a result of an error, one cooperating laboratory depleted its supply of Republican River sand for the Conrow test and so supplemented the natural sand with fine aggregate produced by crushing of the gravel. For these mixes the expansion of the specimens containing the low-alkali cement is reduced to less than one-tenth that obtained with the same cement and the natural sand by the other laboratories. The average expansion of bars containing the high-alkali cement is reduced about 50 per cent and that of the medium-alkali cement specimens about 82 per cent by this substitution of crushed fine aggregate for natural sand. These results should not be taken to indicate that use of crushed coarse aggregate as fine aggregate can be regarded as a generally applicable means to control adverse cement-aggregate reactions in mortar or concrete.

A complete report, involving statistical evaluation of the test results and petrographic examination of selected specimens, will be prepared by Subcommittee II-b.

Control of Chemical Reactivity of Aggregates

Control of deleterious chemical reactions involving aggregates in concrete and mortar depends upon three factors: (1) reduction in the amount of potential reactants available in the cement, aggregate, and admixtures, (2) use of admixtures or agents which impede or prevent deleterious cement-aggregate reactions, (3) control of the structure and properties of the concrete so as to minimize distress without necessarily preventing the chemical reactions.

Reduction in Amount of Reactants:

Aggregates.—Potential reactivity of aggregate at a job can be controlled by selection of aggregate free from significant amounts of deleterious constituents, or, under unusual circumstances, by processing to remove deleterious constituents which happen to be amenable to breakdown in crushing, washing, screening, or to flotation, or to separation by other methods. If nonreactive aggregates can be obtained at no greater cost than can potentially reactive aggregate, the solution is obvious. If nonreactive aggregates are not available or are available only at significant increase in cost, the physical properties of deleterious constituents should be established as a basis for evaluating processing methods directed to their elimination. If reactive materials form coatings or occur as exceptionally soft or lightweight particles, separation might be effective. However, in all but rare cases, at least a significant proportion of the reactive constituents do not differ significantly in physical properties from nonreactive constituents. Hence, they are not amenable to physical separation.

Selection of Cements.—As an alternative to selection of nonreactive aggregate, the common expedient is use of low-alkali cements, which generally are defined as cements containing 0.60 per cent or less of Na_2O and K_2O, expressed as equivalents of Na_2O. Application of this limitation has been widely effective in controlling alkali-aggregate reaction in concrete, and no examples have come to our attention demonstrating conclusively that deleterious expansion has developed as the result of alkali-aggregate reaction in structures in which the cement contained less than 0.60 per cent alkalies, as Na_2O. However, in the laboratory deleterious expansion, as the result of alkali-aggregate reaction, has been reported for combinations in which the cements contained less than 0.2 per cent total alkalies as Na_2O (5). Expansion as the result of

heating-drying and cooling-soaking has been obtained with certain aggregates and cements containing less than 0.1 per cent alkalies, as Na_2O.

Removal of Alkalies from Admixtures and Aggregates.—Evidence at hand demonstrates that under certain conditions pozzolanic admixtures and fine aggregates can release alkalies in sufficient quantities to augment alkali-aggregate reaction, especially if low-alkali cements are used. The effectiveness of the released alkalies, of course, depends upon available potentially deleteriously reactive constituents in the aggregate. Release of alkalies by pozzolanic admixtures or by fine aggregates can be avoided by selection of materials not subjected to such release or, in some instances, by washing or chemical treatment. Washing is effective if the alkali-containing compounds are water soluble; chemical treatment, as with acids or calcium solutions, is effective if the alkali release results from cation exchange reactions.

Control of Water.—Water is an essential reactant in alkali-aggregate reaction in concrete and mortar, both in dissolving alkalies and thus permitting their attack upon susceptible particles of aggregate, and in hydrating and swelling the alkalic-silica gels produced by the reactions. It is easy to demonstrate the inhibition of alkali-aggregate reaction in laboratory specimens from which water is removed by drying. However, water used in the mix is sufficient, if retained in the concrete, to permit alkali-aggregate reaction to progress sufficiently to cause expansion and cracking. Storage of small specimens in moist air or larger specimens in water usually accelerates and increases the deleterious effects.

Waterproofing of field structures, especially hydraulic works, presents a difficult problem. However, if practicable and effective means are developed, amelioration, though not complete stoppage of the reaction, might be expected. At Stewart Mountain Dam on the Salt River in Arizona, the rate of upstream deflection of the structure decreased by a factor of four, from $\frac{1}{2}$ to $\frac{1}{8}$ in. per year, immediately following grouting of vertical contraction joints.

Use of Admixtures and Agents:

Certain pozzolanic admixtures will control alkali-aggregate reaction and the cement-aggregate reaction involving the sand-gravel aggregate, if used in sufficient proportion (8, 9, 10). Opal and calcined clays of kaolinite and calcium-montmorillonite types, as well as certain rhyolite pumicites and fly ashes, react with sodium and potassium in the presence of hydrating portland cement. Thus, they can effectively prevent the attack by the alkalies on the aggregate. Tests demonstrate the pozzolans owing their alkali reactivity to opal will control deleterious reactions if used to replace at least 15 per cent by weight of the portland cement in a 1:2.25 mix if the cement contains 1.1 per cent alkalies, as Na_2O. If used in lesser proportion with cements of this alkali content, the opaline pozzolans might augment the deleterious reactions. Similar relations can be established between various alkali contents of cements and the minimum proportion of opaline pozzolans necessary to control alkali-aggregate reaction in mortar or concrete.

Work by Scholar and Peyton (11) and Conrow (5) also demonstrates that several pozzolans, including calcined clays and shales and fly ash, improve resistance of concrete to volume change in the wetting-and-drying, heating-and-cooling tests.

W. J. McCoy and A. G. Caldwell (12) have summarized tests indicating that expansion of mortar resulting from alkali-aggregate reaction can be markedly reduced by addition of small amounts of lithium salts and other inhibitors. This line of investigation merits further research.

Control of the Structure and Properties of Concrete and Mortar:

Effects of alkali-aggregate reaction can be reduced by introduction of void spaces into the concrete or mortar so as to afford reservoirs into which the alkalic-silica gels can escape. The voids may be within aggregate particles, as in highly porous, lightweight aggregate, or in the cement paste as the result of air or gas entrainment. In lean or poorly placed concrete, the interaggregate voids and aggregate pockets also are known to relieve distress to which a dense concrete would be subjected. Extrapolation from available data indicate that expansion of mortar containing high-alkali cement and a very reactive aggregate can be reduced considerably by entrainment of 7 to 20 per cent of air, the amount of entrained air required depending upon the agent used and the nature of the cement-aggregate combination. Entrained air also tends to reduce expansion of concrete caused by alkali-aggregate reaction, although the effectiveness varies widely in different concretes, and air entrainment alone does not afford adequate protection for an otherwise highly reactive cement-aggregate combination.

Scholer and Gibson (8) and others have found the admixture of certain coarse aggregates with the sand-gravel aggregates to reduce the expansion and cracking otherwise observed with alternate wetting and drying and heating and cooling of the concrete. They report that the characteristic deterioration associated with sand-gravel aggregates has never been observed in service where the total aggregate contains on the order of 60 per cent by weight of limestone coarse aggregate. They note that soft and absorptive limestones are more effective in this regard than is quartzite sandstone. The mechanism by which the introduction of coarse aggregate impedes the deterioration is not known.

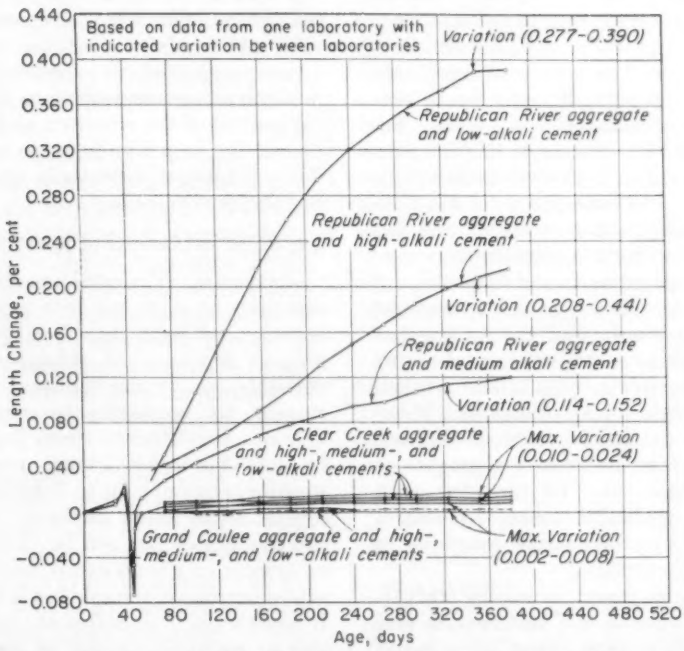

Fig. 3.—Results of Cooperative Tests, Proposed Tentative Method of Test for Potential Volume Change of Cement-Aggregate Combinations Subjected to Variations of Temperature and Water Saturation.

Conclusion

It is the conclusion of Subcommittee II-b that continued investigation will afford additional and more reliable methods by which potentially reactive aggregates can be detected in advance of use, and means by which such aggregates can be used in the manufacture of durable concrete. As a basis for these investigations, research must reveal the chemical and physical processes involved in the many reactions of aggregates; the effects of these reactions on performance of concrete and mortar; and the influence of reactants, admixtures, and physical conditions on the rate, degree, and effects of the reactions.

Acknowledgments:

The author wishes to express appreciation to Chairman W. C. Hanna, Bryant Mather, and other members of Subcommittee II-b, Committee C-9, for careful review and comment on this report. Data summarized in Figs. 1, 2, and 3 were derived from cooperative tests being conducted in six laboratories under the sponsorship of Subcommittee II-b.

References

(1) T. E. Stanton, "Influence of Cement and Aggregate on Concrete Expansion," *Eng. News Record,* Vol. 124, p. 171 (1940).

(2) Duncan McConnell, R. C. Mielenz, W. Y. Holland, and K. T. Greene, "Cement-Aggregate Reaction in Concrete," *Proceedings,* Am. Concrete Inst., Vol. 44, p. 93 (1948).

(3) C. E. S. Davis, "The Effect of Soda Content and of Cooling Rate of Portland Cement Clinker on Its Reactions with Opal in Mortar," *Australian Journal Applied Sci.,* Vol. 2, p. 123 (1951).

(4) D. O. Woolf, "Reaction of Aggregate with Low-Alkali Cement," *Public Roads,* Vol. 27, p. 50 (1952).

(5) W. C. Hanna, "Unfavorable Chemical Reactions of Aggregates in Concrete and a Suggested Corrective," *Proceedings,* Am. Soc. Testing Mats., Vol. 47, p. 986 (1947).

(6) A. D. Conrow, "Studies of Abnormal Expansion of Portland-Cement Concrete," *Proceedings,* Am. Soc. Testing Mats., Vol. 52, p. 1205 (1952).

(7) Roger Rhoades and R. C. Mielenz, "Petrographic and Mineralogic Characteristics of Aggregates," Symposium on Mineral Aggregates, Am. Soc. Testing Mats., p. 20 (1948). (Issued as separate publication *ASTM STP No. 83.*)

(8) C. H. Scholer and W. E. Gibson, "Effect of Various Coarse Aggregates upon the Cement-Aggregate Reaction," *Proceedings,* Am. Concrete Inst., Vol. 44, p. 1009 (1948).

(9) William Lerch, "Studies of Some Methods of Avoiding the Expansion and Pattern Cracking Associated with the Alkali-Aggregate Reaction," Symposium on Use of Pozzolanic Materials in Mortars and Concretes, Am. Soc. Testing Mats., p. 153 (1950). (Issued as separate publication *ASTM STP No. 99.*)

(10) R. C. Mielenz, L. P. Witte, and O. J. Glantz, "Effect of Calcination on Natural Pozzolans," Symposium on Use of Pozzolanic Materials in Mortars and Concretes, Am. Soc. Testing Mats., p. 43 (1950). (Issued as separate publication *ASTM STP No. 99.*)

(11) C. H. Scholer and R. L. Peyton, "Experience with Pozzolanic Materials in Kansas," Symposium on Use of Pozzolanic Materials in Mortars and Concretes, Am. Soc. Testing Mats., p. 31 (1950). (Issued as separate publication *ASTM STP No. 99.*)

(12) W. J. McCoy and A. G. Caldwell, "New Approach to Inhibiting Alkali-Aggregate Reaction," *Proceedings,* Am. Concrete Inst., Vol. 22, p. 693 (1951).

APPENDIX

Summary of Two Proposed Methods of Test

Proposed Tentative Method of Test for Potential Abnormal Expansion of Cement-Aggregate Combinations:

The test employs 3 by 3 by 16-in. concrete beams containing the same mix parts as are to be used in the construction. Following mixing, the specimens are stored for 24 hr at 65 to 75 F covered by wet burlap; then in a moist condition at 73.4 ± 3 F until they are 7 days old; then at 73.4 ± 3 F at 50 ± 5 per cent relative humidity until they are 28 days old; and then in water at 73.4 ± 3 F until they are 30 days old.

After an age of 30 days, the specimens are subjected to alternate heating-drying at 130 ± 3 F for 8 hr and cooling-soaking at 70 to 80 F for 16 hr.

Length change at the end of each 20 cycles of heating-drying and cooling-soaking is referred to length of the specimens at an age of 24 hr.

Proposed Tentative Method of Test for Potential Volume Change of Cement-Aggregate Combinations Subjected to Variations of Temperature and Water Saturation:

The test employs 1 by 1 by 11¼-in. mortar bars with 1 part portland cement to 2.25 parts of graded aggregate by weight. Mixing water is adjusted to achieve a stipulated flow. Fine aggregate is graded in accordance with specifications prepared for the project. Coarse aggregate to be subjected to the test is crushed and graded 20 per cent by weight each of the Nos. 4–8, Nos. 8–16, Nos. 16–30, Nos. 30–50, and Nos. 50–100 size fractions.

Following mixing, the specimens are stored in a moist closet or moist room at 73.4 ± 3 F for 24 hr; then for 24 hr in metal containers holding three specimens which are immersed in water at 73.4 ± 3 F. Following this treatment, the reference length of the specimens is measured. The specimens are returned to the same containers and are again immersed in the same water at 73.4 ± 3 F until they have attained an age of 28 days. The containers holding the water and specimens then are stored at 131 ± 3 F for 7 days; cooled to 73.4 ± 3 F for 24 hr; and then the specimens are removed from the containers and stored at 131 ± 3 F for 7 days in an oven. The specimens then are returned to their respective containers and water and stored at 73.4 ± 3 F.

Length change is determined at several points in the curing period and at intervals of 28 days after return to the containers following drying, the change being referred to the length determined at an age of 48 hr.

Editor's Note.—This paper and the two following were presented at a meeting of ASTM Commitee D-8 on Bituminous Waterproofing and Roofing Materials held during the 56th Annual Meeting of the Society at Atlantic City, June 28 to July 3, 1953.

Effects of Thermal Shock on the Durability of Asphalt Coatings Under Accelerated Test

By Sidney H. Greenfeld[1]

SYNOPSIS

Three asphalts, representative of the major sources of coating asphalt used in the manufacture of prepared roofings in the United States, were exposed, without stabilizer and with 30 per cent and 60 per cent of two mineral stabilizers, to accelerated durability tests. Four panels of each coating were subjected daily to 21 hr of exposure to the radiation from an enclosed, low-intensity carbon arc, with the introduction of a chilled water spray (40 F) for 3 min every 20 min (17-3 cycle). Two of the four panels with each coating were also exposed to air at −5 F for 2 hr daily. The use of the 40 F water produced results equivalent to those obtained when both the 40 F water and exposure to air at −5 F were employed.

BECAUSE of the continual change in the sources of asphalts and the relatively long life of roofings made from them, the need for an accelerated test for determining the probable durability of asphalt has long been recognized. Exposure of films of asphalt to the radiation of a carbon arc and intermittent water spray has been generally accepted as a useful way of determining the durability of a new asphalt relative to that of an asphalt of known performance, if the two are exposed at the same time in the same machine. Beyond the use of radiation and water, there has been little agreement on what other factors should be included in an accelerated durability test or on the amount and intensity of any of the exposure factors.

In 1939, the Society published as tentative, a recommended procedure for conducting accelerated durability tests.[2] Three 24-hr exposure cycles were included, to be used at the discretion of the operator, because "...weather varies considerably from place to place." In all three cycles, there was included a period of $1\frac{3}{4}$ hr of exposure to air at −10F. In 1943, Weetman[3] conducted a systematic study of many of the variables involved in "accelerated weathering" using a cycle very similar to the ASTM "A" cycle. Among other things, he found that in the range of −10 to +10 F, the refrigeration temperature did not affect the results.

Since that time, the commercially available models of Weather-Ometers have been changed in design to include in them more automatic features, and many laboratories have adopted other cycles, which required less attention to the machines. The use of refrigeration as an adjunct to the radiation and water exposure of asphalts has been discussed frequently without resulting in any definite statement of its merits.

However, it was generally agreed that in planning an extensive program, in which a large number of asphalt coating specimens would be subjected to accelerated durability tests, some form of thermal shock should be included, and that it would be desirable to introduce the shock in a manner less cumbersome than the procedure of transferring specimens to and from a freezer. It was decided to investigate the application of this shock directly in the accelerated durability machines by using an automatically controlled cold-water spray (40 F) as part of the exposure cycle. To establish the effectiveness of this procedure, duplicate panels subjected to this cycle, in addition, would be exposed to air at −5 F for 2 hr daily for comparison purposes.

EQUIPMENT AND MATERIALS

An accelerated durability machine was built at the National Bureau of Standards employing a low-intensity, enclosed, a-c arc[4] as a source of radiation. It was similar to commercial machines[4] but in addition to the regular voltmeter, ammeter, time and cycle clocks, it had a kilowatt-hour meter and a time-delay relay, which would turn off the main power supply if the arc should fail for more than 30 sec. A blower provided a continuous circulation of air across the exposed panels.

A commercial demineralizer was used to reduce the salt content of the spray water to less than 2 ppm. This water was chilled to a temperature of 40 F (±2 F) before being sprayed on the panels at a nozzle pressure of 25 psi (±5 psi).

MATERIALS

Three asphalts, representative of those used in the manufacture of prepared roofing in the United States, were

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Research Associate at the National Bureau of Standards, Washington, D. C., representing the Asphalt Roofing Industry Bureau.

[2] "Tentative Recommended Practice for Accelerated Weathering Test of Bituminous Materials" (D 529 - 39 T), 1952 Book of ASTM Standards, Part 3, p. 1393.

[3] Bruce Weetman, "Accelerated Weathering of Bituminous Materials—Effects of Operating Variables," *Proceedings*, Am. Soc. Testing Mats. Vol. 43, pp. 1154-1165 (1943).

[4] Manufactured by the Atlas Electric Devices Company, Chicago, Ill.

TABLE I.—PROPERTIES OF ASPHALTS.

Asphalt	PRODUCT 1			PRODUCT 2		PRODUCT 3		PRODUCT 4		PRODUCT 5		
	Softening Point,[a] deg Fahr	Penetration[b]	Specific Gravity[c]	Softening Point,[a] deg Fahr	Penetration[b]	Softening Point,[a] deg Fahr	Penetration[b]	Softening Point,[a] deg Fahr	Penetration[b]	Softening Point,[a] deg Fahr	Penetration[b]	Specific Gravity[c]
Source I	187	31.7	1.013	197	25.3	211	21.7	213	20.0	223	18.8	1.017
Source II	185	29.0	0.995	196	25.0	211	21.8	220	19.0	231[d]	17.2	1.003
Source III	185	25.3	1.015	189	24.5	207	20.7	218	18.0	224	16.8	1.021

[a] Determined by ring and ball method, ASTM Method D 36-26.
[b] Determined by ASTM Method D 5-49 (at 77 F, 100 g, 5 sec).
[c] Determined only on products 1 and 5.
[d] This product was not used because of its high softening point.

TABLE II.—CHARACTERISTICS OF STABILIZERS.

	Stabilizer A	Stabilizer C
Moisture, per cent, by weight	0.2	0.1
Loss on ignition, per cent by weight:		
1000 F	2.1	1.7
1800 F	5.4	43.6
Water soluble, per cent by weight	0.0	0.0
Free alkali, per cent by weight	0.0	0.0
Sieve analysis, per cent by weight passing U. S. sieves		
No. 60	99.8	99.9
No. 80	99.3	99.9
No. 100	97.9	99.6
No. 120	96.2	99.3
No. 170	91.3	96.6
No. 200	86.9	93.4
No. 270	83.6	89.9
No. 325	76.7	81.0
Particle shape	Flat plate	Blocky
Density, g per cu cm	2.94	2.87
Surface area,[a] sq m per g	1.0	2.0
Oil absorption, g per 100 g (mineral oil)	29.5	19.5

[a] Determined by nitrogen adsorption.

used in this investigation. Each asphalt was commercially processed into five products of different softening points as shown in Table I.

Two commercial, nonmetallic mineral stabilizers, having the properties and attributes shown in Table II, were used in this investigation.

Asphalt products (see Table I) from each source were blended with the proper concentrations of stabilizers to produce coatings (with the exception of 60 per cent stabilizer A) with softening points in the range of 221 to 226 F. Although those containing 60 per cent stabilizer A were made with 40 per cent of product 1, their softening points were as high as 237 F. For identification purposes, each coating is designated by the asphalt source followed by the concentration and letter of the stabilizer; that is, II 60 C is 60 per cent of stabilizer C in source II asphalt.

Preparation and Exposure of Panels

The panels to be exposed were made by spreading the asphalt coating on a $2\frac{3}{4}$ by 6 by 0.064-in. aluminum sheet with the aid of a hydraulic press as described in a separate paper by the author.[5] All coating thicknesses were between 0.023 and 0.027 in., with a maximum variation of ±0.001 in. on any individual panel. Panels were calipered immediately after they were prepared and were exposed within 24 hr.

Six panels were made from each of 15 different coatings: three coatings were made without stabilizers, six with 30 per cent of two stabilizers, and six with 60 per cent of two stabilizers. Two of these panels, designated "1" and "2," were exposed to the four steps of Cycle A:

1. Alternating 17 min of radiation and 3 min of radiation and cold-water (40 F) spray for 21 hr.
2. Inspection for $\frac{1}{2}$ hr.
3. Exposure to air at −5 F for 2 hr.
4. Inspection for $\frac{1}{2}$ hr.

Two of these panels, designated "3" and "4," were exposed to the two steps of Cycle B:

1. Alternating 17 min of radiation and 3 min of radiation and cold-water (40 F) spray for 21 hr.
2. Exposure to air at 77 F for 3 hr.

Cycle A differs from Cycle B only in the 2-hr exposure to air at −5 F.

To compare the results of machine exposure with actual weathering, two panels were exposed out of doors on the roof of the Industrial Building, National Bureau of Standards, at an angle of 45 deg, facing south. (At the end of $2\frac{1}{2}$ yr, no failures had occurred.)

Those panels exposed in the accelerated durability machines were held by stainless steel clips, two to an aluminum support, one above the other. On the odd-numbered days, the supports were inverted; and on the even-numbered days, the panels were inverted in their supports. In this way, the vertical variation in intensity of light and heat was taken into consideration. Once a

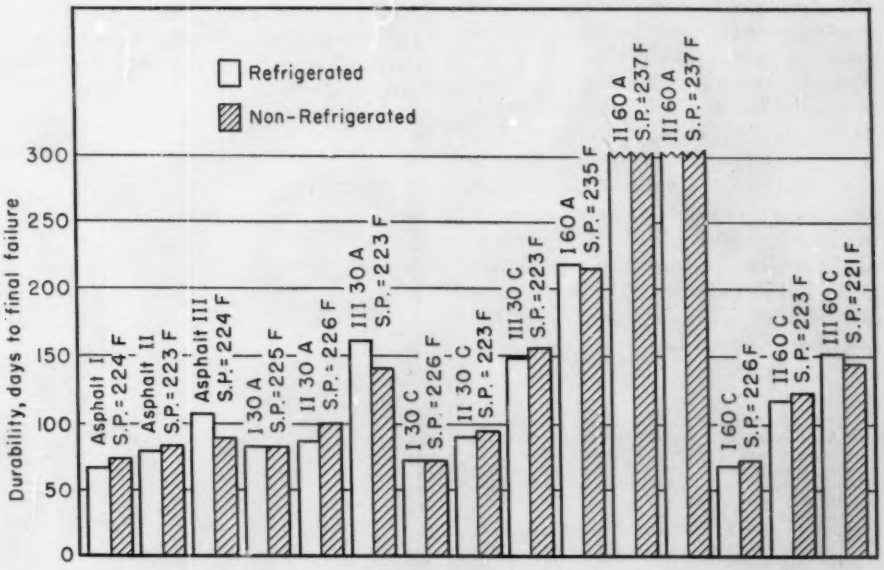

Fig. 1.—A Comparison of the Durability of Refrigerated and Nonrefrigerated Coatings at Final Failure.

[5] S. H. Greenfeld, "A Method for Preparing Uniform Films of Bituminous Materials," see p. 50, this publication.

Fig. 2.—The Most Frequently Occurring Type of Failure Is Represented by Unstabilized Source II Asphalt Shown in This Photograph. The panel on the right was exposed to air at −5 F.

week, all of the panels were inspected by means of a high-voltage probe[6] to detect any openings in the coatings. These inspections were made on dry panels following a water-spray period. In Cycle A, inspections were made both preceding and following the refrigeration period. Those panels showing a partial failure were spark-photographed according to the procedure of Hunter, *et al.*[7] When any panel developed failures on a minimum of 50 per cent of its surface, as determined by means of a 60-square grid (that is, failure in 30 of the 60 areas on the grid) it was removed from the machine as a final failure.

[6] A. H. Boenau and L. H. Baum, "The Design and Application of a Spark-Gap Instrument for Detecting Crack Failures of Asphalt Coatings During Weathering Tests," Symposium on Accelerated Durability Testing of Bituminous Materials, Am. Soc. Testing Mats., p. 153 (1949). (Issued as *ASTM STP No. 94.*)

[7] J. B. Hunter, F. C. Gzemski, and L. Laskaris, "A New Method for Evaluating Failure of Bituminous Materials Due to Weathering," Symposium on Accelerated Durability Testing of Bituminous Materials, Am. Soc. Testing Mats., p. 144 (1949). (Issued as *ASTM STP No. 94.*)

Results

After failure each panel was spark-photographed after it was removed from the machine and was then stored in a dark place at room temperature for future reference. The exposure of those panels containing 60 per cent stabilizer A and asphalts from sources II and III was discontinued after 300 cycles, even though final failure had not occurred.

Table III is a summary of the durability of all of the panels, arranged according to increasing stabilizer concentration. Figure 1 is a bar graph of the data in Table III presenting a comparison of the refrigerated and nonrefrigerated coatings.[8]

In all instances, all four panels of each kind of coating, two refrigerated and two not refrigerated, showed the same type of failure pattern. Figures 2, 3, and 4 are photographs of typical sets of panels showing the similarity of the crack patterns in each set. All of the panels failed with one of these three types of patterns.

Discussion of Results

Because inspections for failures were made weekly, differences in durability of 7 days or less are not significant. From Table III it can be seen that in all but three pairs of panels similarly exposed, failures were revealed either concurrently or during consecutive inspections. Of the three pairs that did not follow this pattern, one was refrigerated, coating II 30 C; and two were not, coating II 30 A and coating III 30 A. Thus, refrigeration added very little to the degree of reproducibility of results.

Figure 1 shows that in only three instances were there more than seven cycles, or one inspection period, difference between the durabilities of the refrigerated and corresponding nonrefrigerated panels. In one case, panels II 30 A, the refrigerated panels failed 13 cycles earlier than the nonrefrigerated ones; but in two cases, panels III and panels III 30 A, the refrigerated panels actually lasted longer than those

[8] For this discussion the term "refrigerated" will refer to the panels that were exposed to air at −5 F.

TABLE III.—DAYS[a] OF EXPOSURE TO FINAL FAILURE.

Coating	Refrigerated Panels[b] (Cycle A)			Nonrefrigerated Panels[c] (Cycle B)		
	Panel No. 1	Panel No. 2	Average	Panel No. 3	Panel No. 4	Average
I	68	68	68	74	74	74
II	79	79	79	86	79	82
III	110	103	106	89	89	89
I 30 A	82	82	82	82	82	82
II 30 A	87	87	87	106	93	100
III 30 A	164	157	160	150	129	140
I 30 C	72	72	72	72	72	72
II 30 C	96	82	89	89	96	92
III 30 C	148	148	148	155	155	155
I 60 A	....	219	219	219	213	216
II 60 A	300[d]	300[d]	300[d]	300[d]	300[d]	300[d]
III 60 A	300[d]	300[d]	300[d]	300[d]	300[d]	300[d]
I 60 C	72	66	69	72	72	72
II 60 C	115	115	115	122	122	122
III 60 C	154	147	150	140	147	144

[a] Multiply by 21 to get hours of radiation, by 2 to get hours of exposure at −5 F (for Panels Nos. 1 and 2), and by 3.15 to get hours of spray.
[b] Inspected after the exposure at −5 F.
[c] Inspected after the spray period.
[d] Discontinued before final failure.

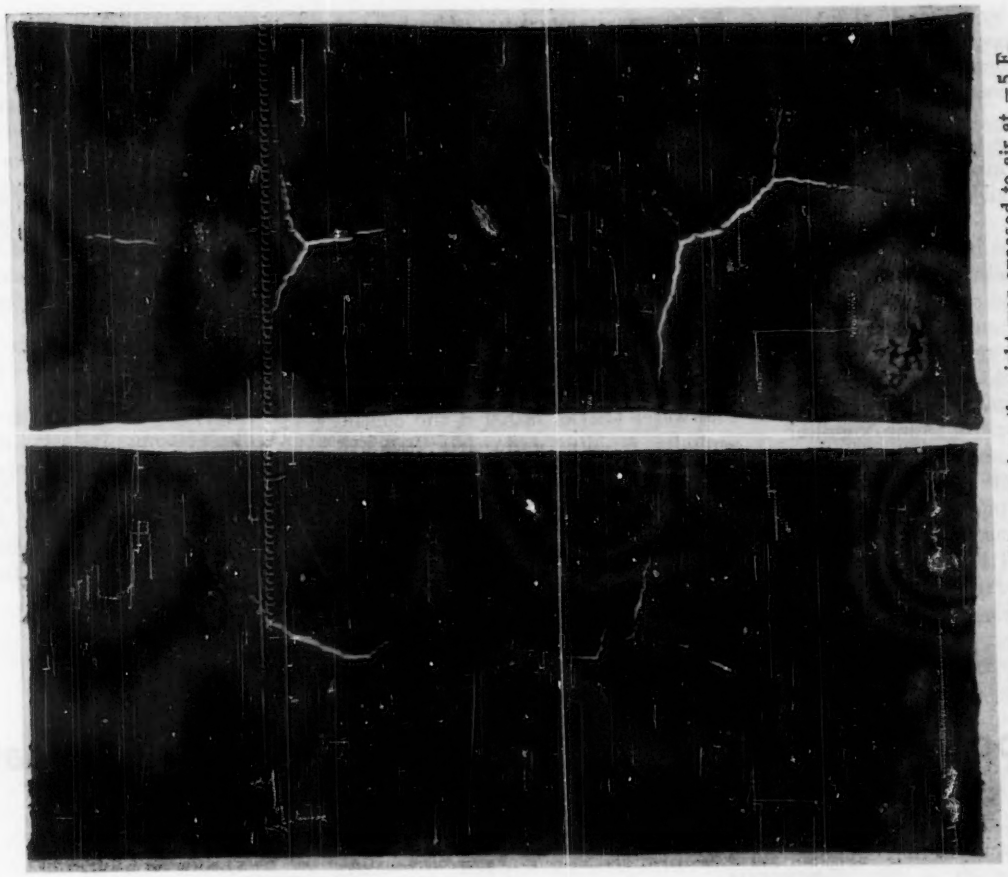

Fig. 4.—Coating II-60A. The panel on the right was exposed to air at −5 F.

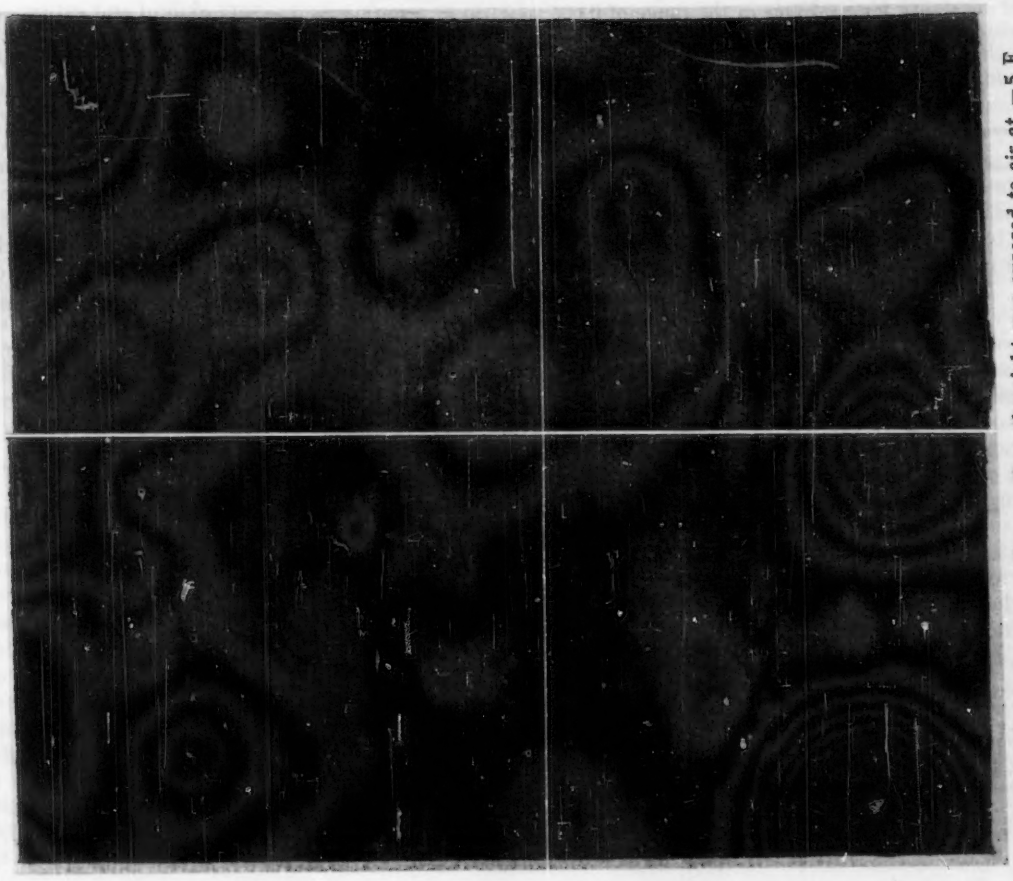

Fig. 3.—Coating I-60A. The panel on the right was exposed to air at −5 F.

not refrigerated by 17 and 20 cycles, respectively! Thus, it must be concluded that refrigeration did not hasten the failure of the coating asphalts under these conditions. (It should be noted that two of these three cases involve asphalt stabilizer mixtures in which the duplicate panels failed more than seven cycles apart.)

The photographs in Figs. 2, 3, and 4 show all of the crack patterns that were present in the failed coatings. In every instance all four panels of each coating, the two that were refrigerated and the two that were not, had similar crack patterns. Refrigeration at −5 F did not modify the type of failure or alter the durability of the coatings in so far as these characteristics were revealed by the spark photographs or the appearance of the crack patterns.

The 17-3 cycle (17 min of radiation followed by 3 min of radiation and water spray) was designed to duplicate in the new machines, in which the drum rotates at 1 rpm, the conditions of exposure that prevailed in the older Weather-Ometers, in which the drum rotated once every 20 min. The chilled water (40 F) was added to increase the thermal shock to which the panels were periodically subjected in order to accelerate the failure and possibly to eliminate the necessity for the use of refrigeration. The data show that for this cycle, exposure to air at −5 F does not alter the durability of the coatings. Further, the frequent periodic cold-water shocks fatigued the coating asphalts rapidly, and very little difference was found between the number of failures after the refrigeration period and after the spray periods, examinations having been made at both times. Thus, if chilled spray water is used, the wide divergence in durability introduced by varying the time of inspection that has been reported by other investigators is no longer apparent.[7]

Conclusions

Exposure to air at −5 F has no significant effect on the durability or failure pattern of both stabilized and unstabilized asphalts under accelerated test if the test includes frequent cyclic thermal shocks.

Acknowledgment:

This work was sponsored by the Asphalt Roofing Industry Bureau at the National Bureau of Standards. The help of members of the NBS staff is gratefully acknowledged. Mr. William H. Appleton, Asphalt Roofing Industry Bureau associate, aided in the laboratory phase of the work.

A Method of Preparing Uniform Films of Bituminous Materials

By Sidney H. Greenfeld[1]

Synopsis

A hydraulic press was adapted to the preparation of uniform films of both stabilized and unstabilized bitumens for exposure out of doors and to accelerated durability tests. Films in the range of 0.005 to 0.050 in. were made consistently within a maximum variation of ±0.001 in. in each film with fewer than 10 per cent rejections. Coatings up to 0.100 in. thick can also be made.

One of the problems encountered in the laboratory testing of bituminous materials is the reduction of these materials to uniform films, for many of their properties are functions of film thickness. The problem has been approached from various points of view with varying degrees of success.

Probably the earliest methods of preparing films of bitumen on rigid supports involved the pouring of the material on the support and heating both, while the support was maintained in a horizontal position, until a more-or-less uniform film was formed. Early investigators recognized the shortcomings of this method, and in 1930, O. G. Strieter[2] described the earliest form of the apparatus in current use. He mounted a heated, hollow, brass cylinder horizontally in such a manner that its height above a wooden bed could be adjusted. A rigid panel covered with molten asphalt was passed beneath this heated cylinder a number of times until the desired film thickness was attained.

An apparatus similar to the above, but in a refined form, became available commercially[3,4] and was adopted by many laboratories throughout the United States. A more advanced apparatus in which the entire bed was moved under a heated, stationary doctor bar by means of a geared drive was developed by Kirschbraun and was also reported by Strieter[2]; however, this apparatus has not been very widely accepted. Because of the surface configurations and irregularities introduced by these "doctor-bar" methods, many investigators gave their panels various heat treatments to produce nearly uniform surfaces.

If the operators of the doctor bar are very skillful and extremely careful, it is possible to obtain a fairly high percentage of acceptable panels when bitumens unmixed with other materials, such as stabilizers, are used. While most investigators find it difficult to maintain a tolerance of ±0.003 in. (in the 0.025-in. range), some claim to be capable of producing a ±0.001-in. tolerance. However, very often streaks are left in the coating, and the asphalt near the surface is changed markedly due to its prolonged exposure to the elevated temperature of the doctor bar. The necessary cleaning and readjusting of the bar after each pass make the task of preparing suitable panels unduly long and onerous.

A new difficulty was encountered using the doctor-bar method when attempts were made to make coatings of bitumens containing mineral stabilizer. It was observed that even during the first pass of the coating under the doctor bar, the appearance of the surface changed materially. The prolonged period at elevated temperatures required for the numerous passes permitted the stabilizer to settle from the surface, leaving it deficient in stabilizer and, consequently, causing the remainder of the coating to be of a higher concentration of stabilizer than desired.

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[2] O. G. Strieter, *Journal of Research*, Nat. Bureau of Standards, Vol. 5, pp. 247–253 (1930) (RP 197).

[3] Panel Trimmer, Atlas Electric Devices Mfg. Co., Chicago, Ill.

[4] H. Abraham, "Asphalts and Allied Substances," 5th Edition, D. Van Nostrand Co., Inc., N. Y., p. 1484 (1945), and "Proposed Method for Accelerated Weathering Tests of Bituminous Materials," *Proceedings*, Am. Soc. Testing Mats., Vol. 33, Part I, p. 383 (1933).

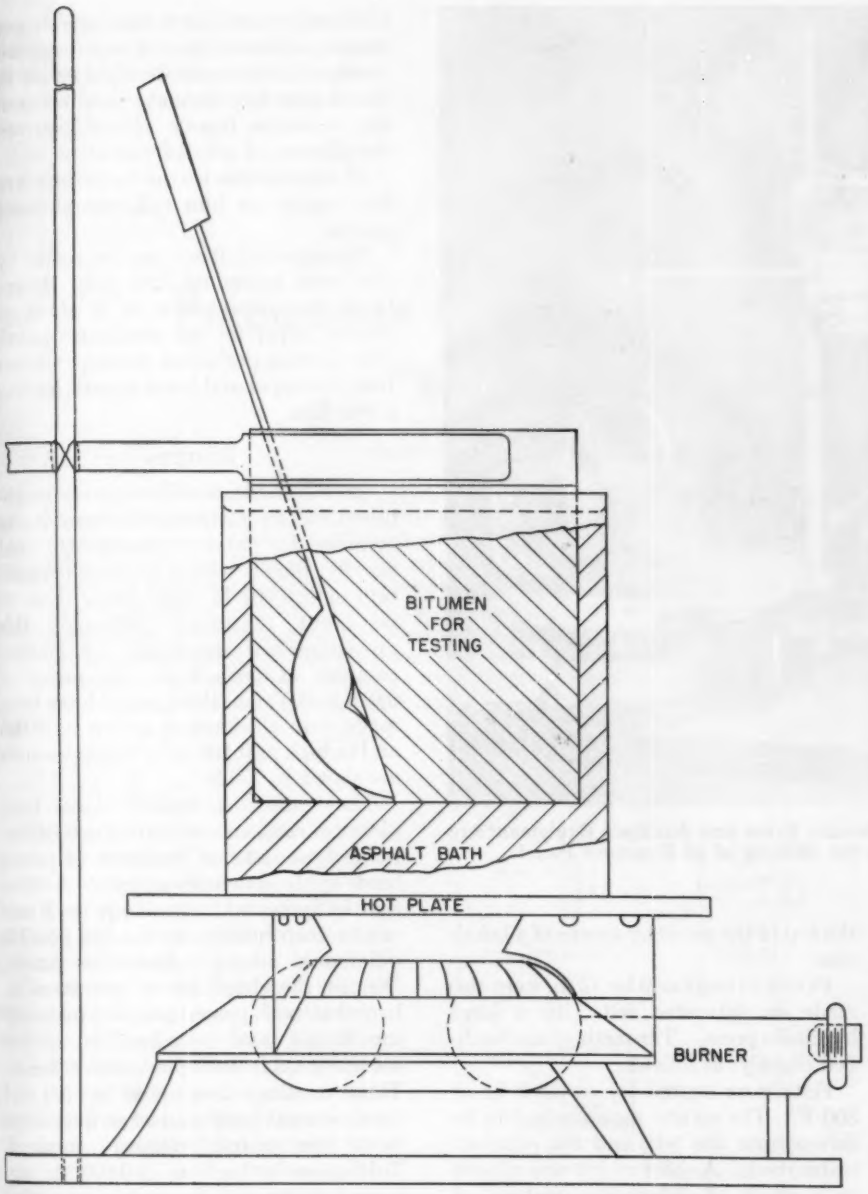

Fig. 1.—Bitumen Melting Bath—The Bitumen Under Test Is Melted in This Type of Asphalt Bath to Prevent Its Being Degraded by Local Overheating.

A method that could eliminate these objections was sought for preparing uniform films of bituminous materials over a wide range of thicknesses. In the search for this method, it was observed[5] that a hydraulic press could be adapted if certain precautions were taken to prevent the bitumen from adhering to the press platens and to retard the cooling of the bitumen until it had spread to the desired thickness. This paper describes the precautions taken to obtain consistently the required thickness and uniformity of coating.

[5] The Ruberoid Co. has used a press with amalgamated platens for a number of years.

Equipment and Materials

The bitumen being tested was melted in the apparatus shown in Fig. 1. The exposure specimens were made on a hydraulic press, which is shown in Fig. 2, together with auxiliary equipment: feeler-gage spacers, variac-controlled hot plate, thickness gage, and aluminum panel fastened to a sheet of kraft paper with masking tape.

The materials used directly for making exposure panels were aluminum-base panels, $2\frac{3}{4}$ by 6 by 0.040 to 0.070 in., kraft and dextrin-coated paper, 6 by 8 by 0.005 in., and gray cardboard, 6 by 8 by 0.020 to 0.030 in. (all calipering ± 0.0005 in.). When the upper platen of the press was heated, the cardboard was omitted and aluminum panels as thin as 0.032 in. could be used.

In addition to the above equipment, a tank of running water, two wide-mouthed glass containers of carbon tetrachloride, metal-marking letters, a vise, a file, and thermometers were used in the procedure.

Preparation of Materials

In order to obtain uniformity of results, it was necessary to clean the aluminum panels well. A number of aluminum panels of the same thickness were calipered, deburred, and placed in the first jar of carbon tetrachloride. After about 10 min, the panels were transferred individually to the second jar of solvent. Each panel was removed individually from the second jar and, after it had air-dried its surface was rubbed with a clean, lint-free cloth to remove any dust or loosely adhering films of insoluble materials. Other methods of cleaning the panel surface may be satisfactory, but this was a minimum treatment. Each panel was fastened to a sheet of kraft paper with masking tape, covering $\frac{1}{4}$ in. on three sides and $\frac{1}{2}$ in. at one of the ends (for the panel number). For the thinner films the tape was not put along the sides of the panels. A panel was put in the hot grill with a thermometer in contact with its surface.

The bitumen was melted in the melting bath at 400 to 425 F, maintained at that temperature, and continually stirred until the sample had a smooth, bubble-free appearance.

A set of spacers was placed on each side of the lower platen; these were equal to the combined thickness of the aluminum panel and the desired coating thickness plus about 0.003 in. to allow for thermal expansion.

Procedure

The panel was removed from the grill when it reached a temperature of 300 F and was placed on a flat, thermally insulated surface. About $1\frac{1}{4}$ times the quantity of bitumen needed was poured on the panel. Any bubbles present were broken by tapping the panel against a solid object or by contacting with a graphite rod; for example, a long-pointed pencil.

The bitumen was covered with a sheet of dextrin-coated paper and a sheet of cardboard (Procedure I). When the upper platen of the press was heated to within about ± 20 F of the softening point of the coating, the upper cardboard was omitted (Procedure II). The timing of the procedure was not nearly so critical when the platen was heated.[6]

[6] Heating the upper platen was suggested in a private communication from G. W. Clarvoe, Johns-Manville, Manville, N. J.

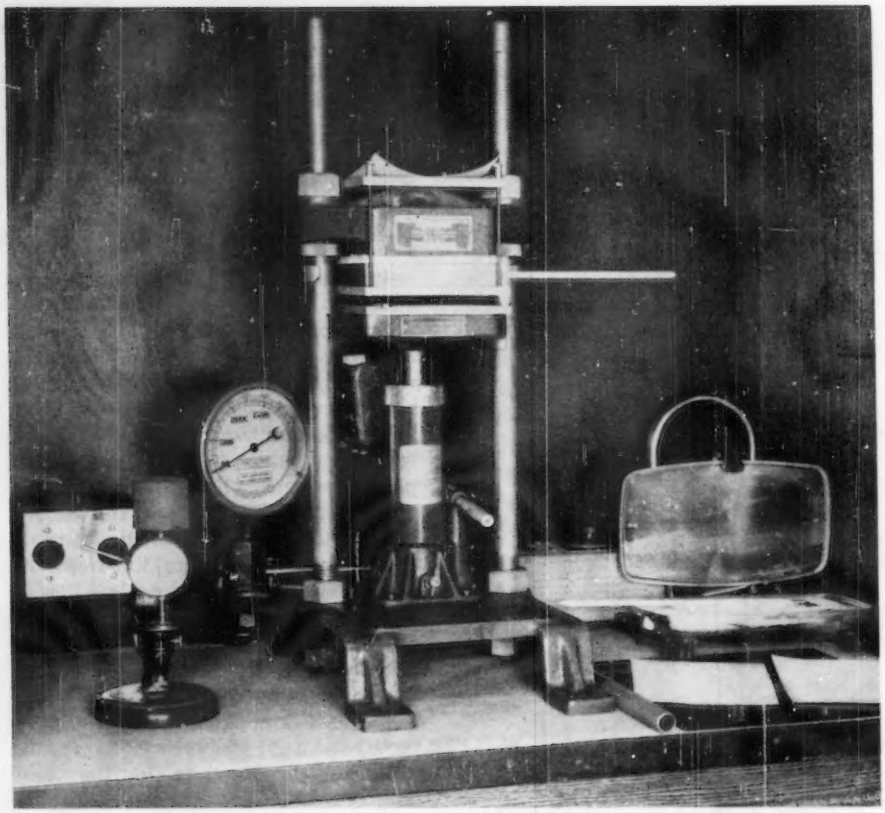

Fig 2.—Panel Making Equipment. The Hydraulic Press and Auxiliary Equipment Are Shown in Operating Positions Prior to the Making of an Exposure Panel.

The assembly was placed in the press in such a manner that the spacers were under the paper and cardboard, but not the masking tape.

The press was closed with a thrust of approximately 3500 lb. This force was taken up by the spacers and was only large enough to insure the spreading of the bitumen to the thickness defined by the spacers before it solidified. The entire procedure took 5 to 10 sec. After about 30 sec, the assembly was removed from the press and the panel was immersed in the water bath. After the dextrin-coated paper floated free, the panel was removed from the water, washed thoroughly, stripped of its masking tape, and dried. The panel was then calipered. The timing of the above procedure was critical when the upper platen was not heated.

The most important single variable, which was subject to control, was the bitumen temperature. Panels were most easily made when the bitumen temperature was such that its viscosity was in the range of 100 to 500 centipoises. However, by adjusting the spacers and the insulation above and below the panel, films of controlled thickness were made from melts with viscosities as high as 10,000 centipoises.

For identification purposes a number was pressed into the bare aluminum at the top of the panel by means of a bench vise.

Panels as large as 9 by 12 in. were also made on saturated felt with a large hydraulic press. The method was modified slightly, as follows:

Felts were heated for about 2 hr at 300 F. The air and moisture had to be driven from the felt, and the saturant reabsorbed. A sheet of felt was placed on a sheet of cellophane (instead of kraft paper) and, after the asphalt was poured, a sheet of dextrin paper and two sheets of kraft paper were placed on it. This assembly was sandwiched between two masonite boards placed between the platens of a large press.

The remainder of the procedure was the same as for aluminum-based panels.

Unsupported films can be made by the press procedure, the only change being the substitution of a sheet of dextrin paper for the aluminum panel. The soaking period, of course, removes both the upper and lower papers, leaving a free film.

Results

Once suitable conditions were established for any particular bitumen, it was possible to obtain, consistently and rapidly, panels with a maximum variation of ±0.001 in. with fewer than 10 per cent rejections. Although this procedure was developed for making coatings of asphalt in the range of 0.010 to 0.050 in. thick, some have been made with thicknesses as low as 0.005 and as high as 0.100 in. Typical results are shown in Table I.

The results in Table I have been picked at random in the 0.013 to 0.043-in. range from data on hundreds of panels made by these two procedures. A variation in individual panels up to 2 mils can be seen readily, as can the possible differences among consecutive panels. Despite the simplicity of operation inherent in both procedures, the necessity for timing and coordination of the several steps in each procedure remains. Those coatings designated by (*d*) and (*e*) show what happened when deviations from the normal timing occurred. Tolerances as high as ±0.003 in. appeared to be an acceptable operating

TABLE I.—REPRESENTATIVE VARIATIONS OBTAINED BY THE PRESS METHOD OF PREPARING ASPHALT FILMS ON ALUMINUM.[a]

Proportion of Stabilizer, per cent by weight	Coating Thickness, mils					
	Procedure I[b]			Procedure II[c]		
	Thickness	Maximum Variation		Thickness	Maximum Variation	
		plus	minus		plus	minus
0	25	0	1	25	0.5	0
	25	1	1	25	1	0
	23[d]	1	1	25	0	1
	25	1	1	25	0.5	1
35	13	1	0	5	1	0.5
	14	1	0.5	5	1	0
	13	0.5	0.5	5	1	0.5
	16[e]	1	1	...	...	...
50	43	0	1	13	1	0.5
	43	0	1	13	1	0.5
	43	0.5	0	13	1	0.5
	43	0.5	0	13	1	0.5
60	13	1	1	25	0.5	1
	14	1	0	25	1	1
	13	1	0.5	25	1	1
	13	0.5	0.5	25	1	0

[a] The coating thickness for each panel is the average, to the nearest mil, of eight measurements; the variations are the maximum deviations from this average.
[b] *Conditions:* Platen at ambient temperature with cardboard insulation above panel.
[c] *Conditions:* Platen heated; no insulation (a few panels have been made with coating thicknesses of 0.100 in. by this procedure with some difficulty).
[d] Press closed too rapidly.
[e] Press closed too slowly.

range when felt-based panels were made, because of the considerably greater variation in the thickness of the saturated felt, as compared with the aluminum panels.

The methods described proved successful on a wide variety of materials including coal tars and many types of asphalt, unstabilized and stabilized with a variety of mineral stabilizers in concentrations up to 60 per cent by weight.

Acknowledgment:

This panel making technique was developed on the Mineral Stabilizer Project, sponsored by the Asphalt Roofing Industry Bureau at the National Bureau of Standards. The author expresses his thanks and appreciation to William H. Appleton for his assistance in the laboratory and to members of the Bureau staff for advice and suggestions.

Preparation of Bituminous Films by Spinning

By Lawrence R. Kleinschmidt[1]

SYNOPSIS

A method is described for the preparation of test coatings by spinning of asphalts, coal-tar pitches, and other solid materials not having fixed melting points, and which will liquefy under 450 F. The method was most effective where a series of coatings was required varying by small increments in thickness. A large number of test specimens can be prepared from a minimum quantity of material in a relatively short time, since no clean-up is required during the coating operation. Coating thicknesses are controlled chiefly by the temperature of the material and the speed of rotation of the test disk. Coatings have been prepared by this method from blown petroleum asphalts in thicknesses ranging from 0.0005 to 0.05 in.

IN THE study of the weathering properties of asphaltic materials, it was desired to make exposures of films having a thickness range less than that which could be conveniently prepared by conventional devices such as the doctor blade.

The preparation of paint and varnish films by spinning was described by Walker and Thompson[2] in 1922. They applied their films to circular ground-glass plates, 10 in. in diameter, rotated at varying speeds. They found that this method produced flat uniform films from varnishes and enamels. The direct application of this method was not suitable for the preparation of films from materials which were not liquids below temperatures of 300 F.

The factors described below controlled the development of the method described herein for the preparation of asphaltic coatings by spinning.

Since the film had to be deposited from molten asphalt, working temperatures up to 450 F were required. Thus, the support to which the asphalt was applied had to be capable of being preheated to insure proper bonding. No aftertreatment of the coating after deposition was desirable. The method had to be sufficiently flexible, so that a large number of specimens varying by small increments in thickness could be quickly prepared. The size and shape of the specimen had to be such that large numbers of them could be conveniently exposed simultaneously in the commercial apparatus for accelerated testing of durability. Furthermore, the size of the specimen had to be such as to provide sufficient material for chemical

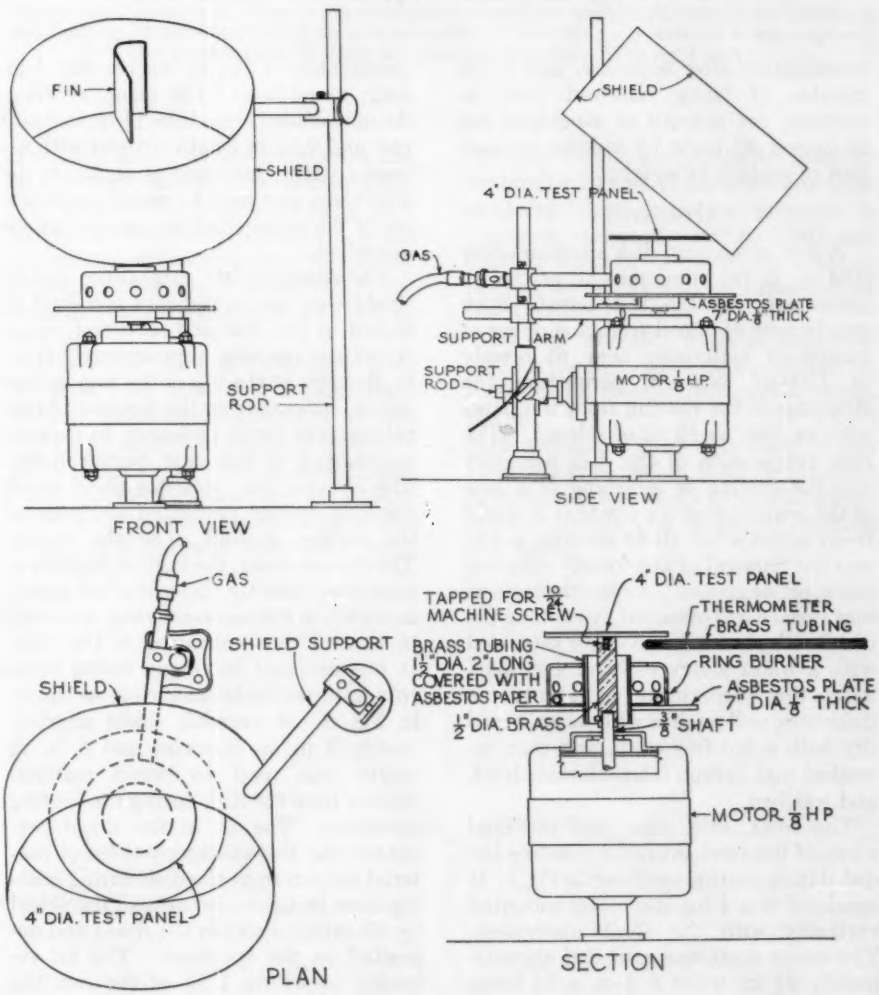

Fig. 1.—Spinning Mechanism.

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[1] Chemist, Floor, Roof, and Wall Coverings Section, Building Technology Division, National Bureau of Standards, Washington, D. C.

[2] P. H. Walker and J. G. Thompson, "Some Physical Properties of Paints," *Proceedings*, Am. Soc. Testing Mats., Vol. 22, Part II, p. 464 (1922).

Fig. 2.—Assembly and Method of Application of Material to Disk.

examination after exposure, and to be capable of being removed with *n*-pentane, the amount of *n*-pentane not to exceed 40 parts by volume to each part of asphalt by weight.

Apparatus

A 4-in. aluminum disk approximately 0.04 in. in thickness met all of the requirements for the test panel. Such panels were obtained from a supplier of handicraft materials; they fit readily in 1500-ml beakers, permitting the stripping of the coating from the panel with as little as 40 ml of solvent. The only preparation of the disk necessary was the drilling or punching of a hole at the center, of such a size that it would freely admit a No. 10-24 machine screw, and the removal of any loosely adhering oxide, oil, or grease. A smooth, uniform mat surface was obtained by rubbing the disks with steel wool (No. 00) saturated with a water slurry of hand grit soap. After this preliminary scrubbing, the disks were well washed with water, wiped dry with a lint-free cloth, and then rewashed with carbon tetrachloride, dried, and weighed.

The front, side, plan, and sectional views of the mechanism for rotating the disk during coating are shown in Fig. 1. It consisted of a $\frac{1}{8}$-hp, d-c motor mounted vertically with the shaft uppermost. The motor shaft was extended approximately $2\frac{1}{2}$ in. using a $\frac{1}{2}$-in. solid brass rod. The top of the mounted rod was tapped at its center to a depth of approximately 1 in. to receive the $\frac{1}{2}$-in. long, round-head 10-24 machine screw. An open-ended brass tube $1\frac{1}{2}$ in. in diameter and 2 in. in length covered with asbestos paper, mounted as shown in the side view, was used to retard overheating of the motor shaft during continuous operation.

The asbestos plate, ring burner, and its shield were assembled and mounted as shown in the side and sectional views. A circular opening approximately 3 in. in diameter in the top of the ring burner shield, concentric to the insulated brass tubing, was found necessary to prevent smothering of the ring burner flame. The circular 7-in. asbestos plate under the ring burner prevented drippage of the molten asphalt onto the motor. The thermometer, the bulb of which was positioned directly under the test panel, as shown in the sectional view, was used to control the preheating of the disk. It was enclosed in loosely fitting brass tubing to facilitate mounting, as shown in Fig. 2. A movable shield approximately 9 in. in diameter and 5 in. in height was used to retain material thrown from the disk during the coating operation. The fin in the shield prevented the thread-like particles of material thrown from the disk during coating from being carried around the shield by air currents within the shield and deposited on the specimen. The fin extended to within 1 in. of the rotating disk.

The motor was connected to the power supply so that it would rotate in a counterclockwise direction. This direction of rotation was found necessary to prevent loosening of the panel-holding screw during operation. Controlled speeds from approximately 600 to 1700 rpm were obtained by the use of a 900-ohm, slide-wire resistance connected in series with the armature; speeds from 1700 to 4000 rpm were obtained by the use of a 1400-ohm, slide-wire resistance in series with the field coils. A telegrapher's sending key connected in one of the power leads facilitated the operation of the apparatus. A 0.5 μ, 400-v, d-c condenser connected across its contact points held arcing to a minimum.

Preparation of the Test Specimens

It was found that heating alone to the pouring consistency was not sufficient to remove all occluded air from blown asphalts. When specimens were prepared, in coating thickness under 0.003, in., from blown asphalts which had been heated only to their application temperatures, the coatings contained a multitude of small air bubbles. To remove this occluded air, the asphalt contained in a 6- or 8-oz, deep metal ointment box was heated with constant stirring on a hot plate until fluid. It was then placed under a vacuum and allowed to partially cool. This cycle was repeated until there was no evidence of excessive foaming immediately after placing under the vacuum. When mineral stabilized coatings were prepared, the stabilizers were added to the asphalt during the first heating period.

It was found that the deep metal ointment box, filled not over three-quarters full, is an ideal container for both the pretreatment and application of the asphalt to the test panels. Due to its small cost, it can be discarded after use. Little material was wasted during the coating operation. A 6-oz container filled three-quarters full was found to be sufficient to coat a series of 10 to 15 panels, ranging in coating thickness from 0.005 to 0.05 in. in thickness, requiring from 0.9 to 9 g of asphalt (specific gravity 1.00) respectively.

A weighed aluminum disk, prepared as described above, was attached, with its burred face down, to the extended motor shaft with the round-head machine screw, and was adjusted so that it rotated free from vibration. The shield was positioned as shown in Fig. 2. The disk, while rotating, was preheated by a low flame from the ring burner to a temperature of 200 to 220 F. The flame was extinguished immediately before coating the disk. The molten asphalt was poured in a thin, continuous stream from a height of 3 to 5 in. onto the rotating disk, starting a little off its

center and ending at the outer edge. The rate of application and the movement of the stream of material across the disk was such that a continuous coating was formed, completely covering the disk to a point slightly ahead of the stream of molten material. The motion of the disk was stopped immediately after being completely coated. The coated disk was removed while still warm and allowed to cool face up on an insulating pad.

It was found that the amount of coating applied to the disk at a given rotational speed varied considerably with the material being used and its temperature. Several experimental panels were usually found sufficient to determine the working tolerances, with respect to the speed of the disk and temperature of the material, to obtain coatings of the desired thicknesses. Determination of the thickness of the coatings was not feasible by a Magne-Gage due to the nonmagnetic backing and the tackiness of the coating; also, the cold flow of the asphaltic coating impaired measurement made with a screw micrometer. The average thickness of the coating was therefore calculated from its weight, specific gravity, and area by the use of the following formula:

$$\text{Thickness, in.} = \frac{\text{weight of coating, g}}{\text{density, g per cu cm} \times \text{area, sq cm,} \times 2.54}$$

The uniform weathering configurations obtained after exposure to different accelerated cycles indicated that the coating distribution over the entire panel area was uniform. Two such panels are shown in Fig. 3. Specimen A, coating thickness 0.002 in., was exposed for 1100 hr to an accelerated cycle involving both light and water. Specimen B, prepared from a different asphalt, also 0.002 in. thick, is shown after 100 hr exposure to light only in the same accelerated unit.

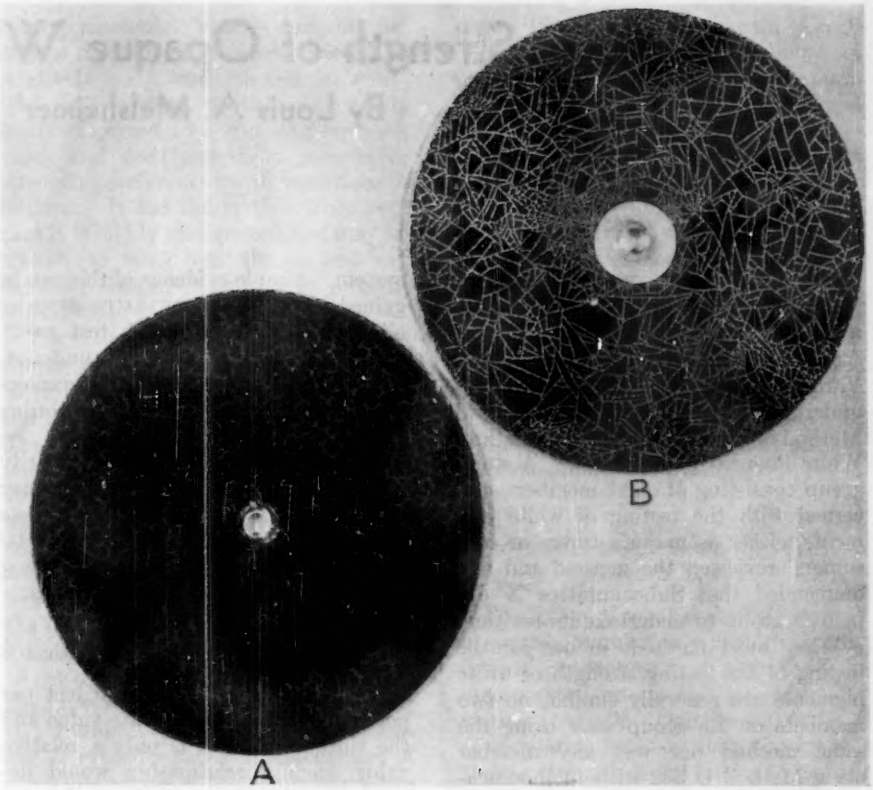


Fig. 3.—Distribution of Weathering Configuration of Two Asphaltic Coatings on Exposure in a Coating Thickness of 0.002 in. to Accelerated Weathering. Specimen A was exposed to a combination of light and water; Specimen B, to light only.

Comments

The principal value of this method of preparing test coatings from solid materials which do not have definite melting points is the ease whereby a large number of specimens differing in small increments of thickness can be quickly prepared from small amounts of material, and the small amount of clean-up required.

The doctor blade and hydraulic press methods have been found more satisfactory where specimens of a specific coating thickness are required, especially in the range above 0.015 in. in thickness.

The spinning method has been found suitable for preparing films from a wide variety of asphalts in a thickness range of 0.0005 to 0.05 in. Asphaltic coatings containing 29 and 44 per cent slate flour as the stabilizer have been prepared in thickness ranges of 0.003 to 0.007 and 0.001 to 0.010 in., respectively, without perceptible changes in distribution of the stabilizer.

By superimposing paper or saturated felts on the disk, films were prepared on these media from blown petroleum asphalts.

It was found also that films in the lower thickness range could be prepared from materials having a narrow softening point range, such as paraffin and stearic acid rosin.

Tinting Strength of Opaque White Pigments

By Louis A. Melsheimer[1]

At the Annual Meeting of the Society in 1952, Subcommittee X on Optical Properties, of ASTM Committee D-1 on Paint, Varnish, Lacquer, and Related Products undertook a study of the Standard Method of Test for Tinting Strength of White Pigments (D 332–36).[2] A study group consisting of eight members concerned with the testing of white pigments, either as manufacturers or consumers, reviewed the method and recommended that Subcommittee X appoint a group to undertake its revision.

While most methods in use for the testing of the tinting strength of white pigments are generally similar, no two members of the group were using the same method nor was any member using Method D 332 without modification. Furthermore, there was a considerable divergence of opinion with respect to details. There was common agreement, however, that the volume ratio of pigment to oil is important and should not be varied to adjust for differences in consistency. It was suggested that the Reynolds constant volume method[3] should be considered, but some doubt was expressed that it is entirely satisfactory.

Relation of Tinting Strength to Hiding Power

In accumulating data on the relative efficiency of titanium dioxide pigments in a number of varied uses in the paint and related industries, the author has found it convenient to compare the relative tinting strength of opaque white pigments with the hiding power they exhibit in paint films. It is common knowledge among paint technologists that the hiding power contributed by a unit weight of an opaque white pigment to a film is increased as the pigment-volume concentration is decreased. It has also been commonly observed that tinting strength is increased with dilution of the pigmented system. Simple evidence of this can be gained by adding a few extra drops of oil to the tinting strength test paste. While not the only cause, it is undoubtedly a contributing factor in the darkening of tinted surface coatings during drying and setting of the film.

For a number of years the similarity in tinting strength and hiding power performance of white pigments has been recognized. In 1930 R. L. Hallett[4] proposed a relationship between tinting strength and hiding power as follows:

$$\text{Hiding Power (sq ft per lb)} = 0.1 \times \text{Tinting Strength} + 3$$

Since hiding power in square feet per pound should be an absolute value and the tinting strength is only a relative value, such a relationship would depend necessarily on the arbitrary numerical rating assigned for tinting strength. The fact that the hiding power measurements were made at the exterior house paint pigment concentration of about 28 per cent by volume and the tinting strength method used had, by chance, about the same volume concentration may have contributed to the correlation obtained. Also the pigment that was assigned a tinting strength of 100 arbitrarily was found to give hiding of 15 sq ft per gal which gave good correlation with the formula. The primary physical factors of high refractive index and light scattering give rise to both the hiding power and the tinting strength contributed by the pigment to an oil film. It is obvious that both lightness and color tinge will affect hiding power and tinting strength differently. The reduction in reflectivity resulting from the addition of a blue pigment will, of course, increase hiding power and at the same time decrease tinting strength as tested with the blue pigment. Thus, a high degree of correlation cannot be expected. However, white pigments having high tinting strength may be expected to give high hiding power.

Methods of Test for Tinting Strength

There are nine different methods of test for tinting strength of white pigments listed in the tenth edition of "Physical and Chemical Examination of Paints, Varnishes, Lacquers and Colors," none of which controls the opaque white pigment volume to a constant value. ASTM Method D 332 specifies for titanium dioxide that amounts of ultramarine blue and oil be used that calculate to a total pigment volume concentration of 43 per cent and an opaque pigment volume concentration of 32.4 per cent. This titanium dioxide pigment volume concentration is higher than is normally used in most industrial and architectural finishes and is higher than the concentration shown by Armstrong and Madson[5] to be most efficient from a paint film opacity standpoint. At higher pigment volume concentrations, the hiding of the finish was shown actually to drop off when applied at uniform film thickness. Of course, at lower volume loadings the hiding of the paint film drops as pigmentation is decreased, but the hiding per unit of pigment increases, as indicated earlier in this paper.

Ultramarine blue dispersed in oil vehicles is extraordinarily transparent[6] and lacking in light scattering characteristics. In the same way blanc fixé, or calcium carbonate, each of which has frequently been used to cut the strength of tinting pigments in the tinting strength test, is quite transparent and lacking in tinting strength when dispersed in an oil vehicle. It is to be expected that from an optical or tinting strength standpoint they will function as nonopaque diluents to increase the total volume and to dilute or reduce the volume concentration of the opaque white pigment under test.

Tinting Strength of Rutile Titanium Dioxide

Tinting strength tests were made with rutile titanium dioxide and the proper amount of oil for mulling consistency, reducing the pigment volume concentration of the titanium dioxide by the introduction of a calcium carbonate extender. The base formula used is as follows:

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Pigment Department, American Cyanamid Co., Calco Chemical Division, Bound Brook, N. J.

[2] 1952 Book of ASTM Standards, Part 4, p. 35.

[3] Henry A. Gardner and G. G. Sward, "Physical and Chemical Examination of Paints, Varnishes, Lacquers and Colors," Henry A. Gardner Laboratories, Inc., Bethesda, Md., 10th Edition, p. 35 (1946).

[4] R. L. Hallett, "Hiding Power and Tinting Strength of White Pigments," *Proceedings*, Am. Soc. Testing Mats., Vol. 30, Part II, p. 895 (1930).

[5] W. G. Armstrong and W. H. Madson, "Economical Use of Titanium Dioxide in Enamels," *Industrial and Engineering Chemistry*, Vol. 39, Aug., 1947, pp. 944–947.

[6] F. B. Havens, "Properties and Applications of Ultramarine Blue," *Calco Technical Bulletin No. 804*, American Cyanamid Co., Calco Chemical Division, Bound Brook, N. J.

1.0000 g rutile TiO_2
0.2508 g ultramarine blue
0.82 g oil

This tinting strength paste had a titanium dioxide volume concentration of 19.6 per cent. A similar paste was made using 0.5000 g of TiO_2 with the introduction of calcium carbonate to give the same total volume. This gave a titanium dioxide concentration of approximately 10 per cent. A third test was made reducing the titanium dioxide to 0.3000 g and increasing calcium carbonate to maintain the same total volume. In this case the titanium dioxide volume concentration was approximately 6 per cent. In all cases the total pigment volume concentration as this value is commonly calculated, was the same. The adjustment in the amount of ultramarine blue tinting pigment necessary to give equal depth of tint was compensated for in the amount of calcium carbonate used. Table I shows the tinting strength values determined in this manner.

TABLE I.—TINTING STRENGTH VARIATION WITH VOLUME CONCENTRATION.

Pigment Combination	Tinting Strength	Equivalent TiO_2 Strength	TiO_2 Volume Concentration, per cent
1.0000 g TiO_2....	1630[a]	1630	19.6
0.5000 g TiO_2 / 0.4530 g $CaCO_3$	945	1890	9.9
0.3000 g TiO_2 / 0.6290 g $CaCO_3$	615	2050	6.0

[a] This is a value determined by routine control method during manufacture, using an arbitrary numerical scale.

If the titanium dioxide tinting strength values shown in Table I are plotted against the opaque pigment volume concentration (o.p.v.), the increase in tinting strength with reduction in titanium dioxide pigment volume concentration becomes readily apparent. This increase in tinting strength is similar in pattern to the increase in hiding power resulting from the use of the pigment at lower volume concentrations. To demonstrate conclusively that the calcium carbonate extender does not contribute significantly to tinting strength, its strength was determined without the presence of opaque pigment. The test was made at the same total particulate volume concentration (P.V.C.) as existed in the tinting strength tests in Table I. As nearly as could be estimated the strength of the calcium carbonate was 33.

Pigment Volume Concentration in Tinting Strength Tests

Most of the tinting strength methods in use utilize ultramarine blue as the tinting pigment. This is desirable for several reasons. In the first place, it is relatively low in strength and not sensitive to flooding phenomena. It is easily dispersed to a constant strength value and does not show progressive strength development with variations in mulling. It has the further advantage that it is highly transparent and may be considered along with the oil and any extender pigment that may be present, as a diluent of volume.

The concept of fixed pigment volume concentration was proposed by C. E. Reynolds in 1935 and is described in the Reynolds constant volume method.[7] The Reynolds method maintains a total particulate volume concentration of 46 per cent (P.V.C.). This includes tinting color, ultramarine blue, barytes used to extend the ultramarine blue, and any extender that may be present with the opaque white pigment. As the method applies to anatase titanium dioxide, the o.p.v. will be approximately 13 per cent, while if it is applied to rutile the o.p.v. is 10.5 per cent. If it is applied to a titanium calcium pigment containing an extender as a component part of the white pigment, the composite white pigment volume concentration is approximately 26 per cent, whereas the TiO_2 volume concentration is only about 6.25 per cent.

The current standard method of test, Method D 332 – 36, states specifically in its scope that the method is "only to be used for a comparison of the sample and a reference standard of the same type of white pigment." Interpretation of just what "the same type" means might be open to question. It is clear and well agreed that pigments of different type may not be compared under the present methods of test. If one innocently attempts to evaluate the tinting strength of rutile in comparison with an anatase type as a reference standard, the o.p.v. concentration will be approximately 31 per cent in the case of rutile and 33.2 per cent in the case of anatase. This difference will introduce a significant error in the tinting strength evaluation amounting to about 3 per cent, unless the opaque pigment volume concentration is equalized. The rutile would show an abnormally high strength value. Carrying the line of thought further, if one were to compare a reduced titanium pigment, like titanium calcium pigment, with a pure titanium dioxide pigment using the proportions specified in Method D 332, a grossly erroneous value would be obtained, since the opaque pigment volume (TiO_2 volume) is at a 12 per cent level instead of a 30 per cent level. The unreliability of such a comparison may not be appreciated by the occasional user of the test method.

The commercial range of titanium dioxide content in white finishes will be from about 12 to 20 or 25 per cent opaque pigment by volume on the basis of the nonvolatile constituents, whether extender is present or not. In tinted finishes it may be substantially lower than 12 per cent. When the titanium dioxide is present at much higher volume concentrations, it is less efficient, although higher concentrations may be necessary in some cases to attain the very maximum film opacity.

Practical Significance of Tinting Strength Values

Prediction of what a pigment will do in actual formulation will undoubtedly depend on factors that cannot all be incorporated into a test procedure for tinting strength. One reason for lack of correlation between hiding power and tinting strength is the failure to control the o.p.v. in the tinting strength test, whereas most data on hiding power are determined at controlled spreading rates of the opaque pigment that is under test. A fixed spreading rate in grams per square foot of contrast area is somewhat analogous to a fixed ratio of tinting color to opaque white pigment in the tinting strength test. In each case the ratio of obscured to obscuring substance is fixed.

It is recommended that consideration be given to revision of the tinting strength test for white pigments to establish the proportions of ingredients to maintain uniform opaque pigment volume concentration among the pigments in any class commonly intercompared. It is further recommended that the test be so designed that the volume concentration of the opaque pigment will be at a commonly used average commercial level, so that the test data may correlate as nearly as possible with the opacifying, masking, whitening, or tinting strength that is found in commercial practice.

Since, like hiding power, the tinting strength obtained through the use of an opaque white pigment varies as an inverse function of its volume concentration, evaluation for research, economic, or commercial purposes should be made over a range of concentrations. This is particularly important when quite dissimilar pigments are compared, that is, those that would be used at widely different concentrations in industrial applications. For instance, if lithopone is to be compared

[7] Henry A. Gardner and G. G. Sward, "Physical and Chemical Examination of Paints, Varnishes, Lacquers and Colors," Henry A. Gardner Laboratories, Inc., Bethesda, Md., 10th Edition, p. 45 (1946).

with titanium dioxide, it would be illogical to make the comparison at the high concentration at which the lower strength pigment is normally used. It might be more logical to make the comparison at equal strength using a transparent extender with the titanium dioxide to adjust the total pigment (particulate) volume concentration, if it is not certain just what constitutes the opaque portion of the pigment for calculation purposes.

Evaluations of dissimilar pigments inevitably will be attempted. Such comparisons are almost certain to be misleading unless the opaque pigment volume concentrations are known and considered in the interpretation of results.

Since there is no absolute method of expressing tinting strength as such, only a relative value may be recorded. This is adequate in the comparison of similar pigments for specification buying. For commercial evaluation of types of pigments and formulation development work numerical values are highly useful. A numerical scale now in use[7] might be adequate if the relative values now published were revised to base them on data determined at equal o.p.v. concentrations. If some agency like the National Bureau of Standards were to set up a standard white pigment to be arbitrarily pegged at 100 tinting strength for reference purposes when tested in a specified manner (Federal Method of Test for Tinting Strength), it would be a service to industry. It would provide a basis for plotting tinting strength values against volume concentration so that comparisons between dissimilar pigments may be made more meaningful.

SUMMARY

This paper has, in a general way, reviewed the existing test methods for tinting strength of white pigments. The philosophy of testing opaque white pigments for tinctorial strength has been considered and certain factors that may influence the relative strength have been discussed. It has been proposed that relative tinting strength tests be made under conditions that will maintain equal opaque white pigment volume concentration in all comparative tests by incorporating, where necessary, a substantially transparent extender with highly opaque pigments, like pure titanium dioxide, in order that the tinting strength evaluation shall be at the level of concentration normally used in commercial products. It has been emphasized that comparative tests, to be meaningful, must be carried out at equal o.p.v. concentrations.

Discussion of Paper on New Degreasing Evaluation Test[1]

MR. A. M. MANKOWICH.[2]—I believe it of importance that readers be made familiar with the "residue-pattern" test mentioned by the authors. The "residue-pattern" test was developed in order to provide a confirmation of the water-break test, the latter being a very practical and simple test to perform. The disadvantage of the water-break test is that false water film continuity due to mechanical overlapping of small residual soil spots or to adsorption of detergent on residual soil with protruding hydrophilic groups may result in erroneous conclusions relative to cleaning efficiency. The water-break test is also qualitative only.

The "residue-pattern" test, developed in 1947, takes the usual cleaning test specimen after standardized specimen preparation, soiling, aging, cleaning, and rinsing, and causes it to be dried at 70 C for 15 to 20 min. Residual soil then appears in small stains, easily observed even on a test specimen prepared with No. 1 emery paper. The beauty of the test lies in the fact that efficient cleaners leave very few, or no, residue spots, perhaps $\frac{1}{8}$ in. in diameter, or $\frac{1}{16}$ or $\frac{1}{32}$-in. spots. These spots are easily calculated to total stained area. Accuracy is high. If a cleaner is so inefficient as to leave more than a very few, small stains, it is not worth-while to calculate "cleaning indices," but to proceed to the more efficient detergents. However, if desired, the stained area is permanently fixed on the test specimen, and its magnitude may be estimated by the customary means, with no further treatment of the test panel being necessary.

MR. H. B. LINFORD (*authors' closure*).—Mr. Mankowich has indicated the desirability of explaining the residue pattern. Since the short article published in the ASTM BULLETIN did not allow room for complete discussion of all previous degreasing evaluation tests, it is hard to understand why Mr. Mankowich insists that the residue pattern be singled out for more complete presentation than other previously used degreasing evaluation tests. The references to *Plating* given in the ASTM BULLETIN article do discuss, in some detail, all of the tests listed in Table II.

Mr. Mankowich, in his discussion, has elaborated on the uses of the residue pattern beyond the point covered in his previous articles. Furthermore, conditions for drying the sample are changed from his publication,[3] the principal difference being an increase in temperature. One of the difficulties encountered with oils that will spread rapidly is that even at the 50 C formerly recommended by Mr. Mankowich, these oils spread so rapidly as to obliterate any cleaning index. At 70 C, this spreading rate is increased tremendously.

With respect to Mr. Mankowich's comments on panels with less than 99 per cent cleaning index, we wish to reiterate that these panels were deliberately undercleaned in order that the difference in sensitivity of the tests could be obtained. We believe it is perfectly understandable that if all panels were cleaned 100 per cent, no difference could be shown by any test. In comparing several good cleaners, it is necessary that the cleaning index be under 100 per cent in order that sensitive evaluation of differences may be made.

[1] H. B. Linford and E. B. Saubestre, "A New Degreasing Evaluation Test: The Atomizer Test," ASTM BULLETIN, No. 190, May, 1953, p. 47 (TP 73).

[2] Chemist, Darlington, Md.

[3] *Metal Finishing*, Vol. 45, No. 12, p. 78 (1947).

PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column.

NOTE—*These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.*

Howard S. Avery, Assistant Metallurgist, American Brake Shoe Co., Mahwah, N. J., has been elected Vice-President of the Metal Science Club of New York.

Hugh F. Beeghly, Head of the Applied Science Section, Div. of Metallurgical Research, Jones & Laughlin Steel Corp., Pittsburgh, Pa., has been named Chairman of the Pittsburgh Section of the American Chemical Society.

John T. Blake, Director of Research, Simplex Wire and Cable Co., Cambridge, Mass., received the 1953 Charles Goodyear Medal, presentation being made at the banquet of the Rubber Div., American Chemical Society, during the ACS 124th Annual Meeting in Chicago in September. Dr. Blake was praised for his energetic and effective application to research in rubber chemistry and technology.

Robert D. Bonney, Vice-President, Conoleum-Nairn, Inc., Kearny, N. J., and J. R. Townsend, Director, Materials and Standards Engineering, the Sandia Corp., Albuquerque, N. Mex., were among four members of the Board of Directors of the American Standards Association honored recently by the ASA with service awards in appreciation of leadership and guidance and in recognition of "statesmanship and vision in advancing the development and use of voluntary standards as instruments of free enterprise."

E. M. Dannenberg has been appointed an Associate Director of Research, Godfrey L. Cabot, Inc., Boston, Mass. Until recently he had been serving as Section Head in the Research and Development Dept.

Ernest W. Dean retired September 1 after completing more than 31 years service with the Standard Oil Development Co., New York City. Joining the Standard Oil Co. (N. J.) in 1922, Dr. Dean at that time was nationally known for his knowledge of the procedures and instruments for the testing of petroleum products. In his capacity of Director, he maintained the high caliber of the Laboratory in these functions and promoted uniformity and accuracy of testing throughout the petroleum industry. A member of ASTM Committee D-2 on Petroleum Products and Lubricants since 1920, he has directed the activities of many subcommittees, and made outstanding contributions to the work of Committee D-2 and the Society generally. Dr. Dean resides at 140 Stanmore Place, Westfield, N. J.

J. G. Detwiler, who retired earlier in the year after many years service as Technologist with the Texas Co., New York City, is doing part-time consulting work in Villanova, Pa.

Gustav Egloff, Director of Research, Universal Oil Products Co., Chicago, Ill., was elected an honorary fellow of the Royal Society of Edinburgh.

J. S. Fawcett, until recently Development Engineer, has been named Director of the Development Laboratories of the Fisher Scientific Co., Pittsburgh, Pa.

Charles R. Haynes, Manager, Rubber Service, Binney & Smith Co., New York City, was honored at the banquet of the Rubber Division of the American Chemical Society during the ACS recent annual meeting, when he was presented with a gift certificate for a high-fidelity recorder-phonograph, in appreciation of his many years of fruitful service as Secretary of the Division.

W. B. Lincoln, Jr., has been elected Assistant Vice-President, Technical Service, Inland Container Corp., Indianapolis, Ind. Mr. Lincoln has been with Inland since 1932 where he has held positions as Development Engineer, Plant Manager, and since 1945, Technical Manager. He is Chairman of the Weatherproof Fibre Box Group Technical Committee. In ASTM Mr. Lincoln is active in Committees D-6 on Paper and Paper Products, and D-10 on Shipping Containers, serving as Chairman of Subcommittee IV on Container Board of the former group.

R. E. Luton has been elected Vice-President in Charge of Refining for Ohio Oil Co., Robinson, Ill. Since 1947 he had been serving as Manager of the Refining Div.

William E. Mahin has been appointed Technical Director of Vanadium Corp. of America, New York City. Formerly a Director of Research for Armour Research Foundation of Illinois Institute of Technology, he will direct technical and research activities at Vanadium's research center now under construction at Cambridge, Ohio.

Joseph Marin, Professor of Engineering Mechanics and Research Professor of Engineering Materials, was recently made Head of the Dept. of Engineering Mechanics at The Pennsylvania State College.

Constantine Mylonas, formerly Director, Lab. for Testing Materials, Athens National Technical University, Athens, Greece, is now Associate Professor of Engineering at Brown University, Providence, R. I.

W. A. Schlueter has retired as President of the Refinery Supply Co., Tulsa, Okla.

Thomas P. Simpson, associated with Socony-Vacuum Oil Co., Inc., for many years, more recently as Director of Research and Development Dept. at Paulsboro, N. J., has been appointed Assistant Director of Manufacturing for the firm's West Coast affiliate, General Petroleum Corp., Los Angeles, Calif.

Burton Smart, for the past six years Sales and Technical Representative of United Carbon Co. in the New York and Charleston offices, has been named Southern District Sales Manager for the company, with headquarters in the Sterick Bldg., Memphis, Tenn.

G. Frederick Smith has been named to receive the ACS 1953 Fisher Award in Analytical Chemistry, presentation to be made at the Spring 1954 meeting of the American Chemical Society in Kansas City. Mr. Smith, who is noted for his work in the analytical application of perchloric acid, retired in 1951 from the faculty at the University of Illinois, after 30 years of teaching, and has devoted himself to his own firm, the G. Frederick Smith Chemical Co., which manufactures the special chemical reagents he has developed.

Walter R. Smith, until recently Chief Research Chemist of Godfrey L. Cabot, Inc., has been appointed an Associate Director of Research by his company.

Frank Tessitor, for a number of years with the U. S. Bureau of Reclamation in Denver, Colo., is en route to Pakistan, having been assigned by the Bureau's Office of Foreign Activities as Technical Adviser to the Pakistan Government in the establishment of an Engineering Laboratory in Karachi. Mr. Tessitor may be addressed—American Embassy, A.P.O. 74, Box K, c/o Postmaster, San Francisco, Calif.

Ray Thomas has been elected to the board of directors of Vimasco Corp., Charleston and Nitro, W. Va. Joining the staff of Vimasco earlier in the year as Executive Vice-President and General Manager, Mr. Thomas previously had been associated for 19 years with the Carbide and Carbon Chemicals Co., South Charleston, W. Va. Active in a number of societies, Mr. Thomas has made important contributions to the work of ASTM Committee C-16 on Thermal Insulating Materials.

Sam Tour, of Sam Tour and Co., Inc., New York City, has been elected President of the Metal Science Club of New York.

NEW MEMBERS...

The following 26 members were elected from August 24 to September 23, 1953, making the total membership 7564 . . . Welcome to ASTM

Note—Names are arranged alphabetically—company members first then individuals

CHICAGO DISTRICT

Andrews, Stephen S., Manager, Product Control, U. S. Rubber Co., Eau Clair, Wis.

Friedberg, A. L., Research Assistant Professor, University of Illinois, 204 Ceramics Bldg., Urbana, Ill.

Simmonds, Forrest A., Chemist, U. S. Forest Products Lab., Madison 5, Wis.

NEW ENGLAND DISTRICT

Houlihan, R. P., Sales Engineer, Gavitt Manufacturing Co., Inc., Brookfield, Mass.

Lowell, Richard R., Technical Director, Louis Desonge Co., Fitchburg, Mass.

NEW YORK DISTRICT

Grumman Aircraft Engineering Corp., Durward Armstrong, Process Engineer, Bethpage, New York.

Stern, George, Vice-President and Technical Director, American Electro Metal Corp., 320 Yonkers Ave., Yonkers 2, N. Y.

NORTHERN CALIFORNIA DISTRICT

Hicks, James C., Director of Refractory Research, Kaiser Aluminum and Chemical Corp., Oakland, Calif. For mail: Route 6, Box 290, San Jose, Calif.

Zimmerman, Joseph, Vice-President, Western Piping and Engineering Co., 123 Kansas St., San Francisco 3, Calif.

PHILADELPHIA DISTRICT

Pennsylvania, Commonwealth of, Dept. of Property and Supplies, Bureau of Standards, Thomas A. Sawyer, Director, Publication Bldg., Tenth and Market Sts., Harrisburg, Pa.

PITTSBURGH DISTRICT

Biltz, Jack C., Sand Technician, Worthington Corp., Petroleum St., Oil City, Pa. For mail: 1026½ W. Third St., Oil City, Pa. [J]*

ST. LOUIS DISTRICT

Butler Manufacturing Co., J. T. Jennings, Jr., Chief Products Engineer, 7400 E. Thirteenth St., Kansas City 26, Mo.

SOUTHERN CALIFORNIA DISTRICT

Luebbers, A. V., Jr., Chief Metallurgist, California-Doran Heat Treating Co., 2830 E. Washington Blvd., Los Angeles 23, Calif.

WASHINGTON (D. C.) DISTRICT

Stewart, Jeffrey R., President, Stewart Research Lab., "Forest Gate" at Franconia, Alexandria, Va.

Wharton, Thomas P., Manager, Container Laboratories, Inc., 1519 Connecticut Ave., N. W., Washington 6, D. C.

WESTERN NEW YORK-ONTARIO DISTRICT

Lundquist, Daniel, Chief, Physical Research, Marlin Rockwell Corp., Jamestown, N. Y.

UNITED STATES AND POSSESSIONS

Barrett, G. D., Cooper, Barrett, Skinner, Woodbury & Cooper, Architects and Engineers, 501–507 Henry Grady Bldg., Atlanta, Ga.

Corps of Engineers, U. S. Dept. of the Army, Savannah District, Box 889, Savannah, Ga.

Guam, Government of, Dept. of Public Works, Director of Public Works, Agana, Guam.

Jones, Chester W., Materials Engineer, Earth Lab., U. S. Bureau of Reclamation, Denver Federal Center, Denver, Colo.

Schunter, William E., State Chemist, Wyoming Dept. of Agriculture, Laramie, Wyo. For mail: 570 N. Tenth St., Laramie, Wyo.

Woodford, T. VanDyke, Materials Engineer, U. S. Bureau of Reclamation, Federal Center, Denver, Colo.

OTHER THAN U. S. POSSESSIONS

Carr, John D., Superintendent of Research, Hudson Bay Mining and Smelting Co., Flin Flon, Man., Canada.

Fulton, Frederick Sandrock, Director, Concrete Association of South Africa, Box 3899, Johannesburg, South Africa.

Jasdanwalla, F. A., Works Manager, The Indian Standard Metal Co., Ltd., Chinchpokli Cross Lane, Bombay 27, India.

van Ouwerkerk, Jan Marinus Lambertus, Welding Supervision, Ltd., 73 S. Audley St., London, W.1, England.

* J denotes Junior Member.

DEATHS...

Edward T. A. Coughlin, Chief, Paper and Pulp Products Section, Research and Development Div., Office of the Quartermaster General, Dept. of Defense, Washington, D. C. (August 20, 1953). Representative of the U. S. Dept. of the Army, Quartermaster Corps on ASTM Committee D-6 on Paper and Paper Products, and its Subcommittees III on Physical Test Methods for Paper, and V on Specifications for Paper. Mr. Coughlin also served on Technical Committee M on Petroleum Wax of Committee D-2 on Petroleum Products and Lubricants, and on the Joint TAPPI-ASTM Committee on Petroleum Wax. He was a Past-President and Life Member of the American Pulp and Paper Mill Superintendents Assn.

Eugene M. Diskant, Research Chemist, Sanitary Engineering Div., Dept. of Water and Power, City of Los Angeles (Calif.) (suddenly, August 24, 1953). Member since 1951, serving on Committee D-19 on Industrial Water, and its Subcommittees IV on Methods of Analysis, and VII on Industrial Waste Water.

Harry L. Ericson, Chief Chemist, Witco Chemical Co., Carbon Black Div., Amarillo, Tex. (August 4, 1953). Member since 1950, and representative of his company on Committee D-11 on Rubber and Rubber-like Materials.

James B. Fisher, Consulting Engineer, Waukesha Motor Co., Waukesha, Wis. (April 8, 1953). Associated with the Waukesha Co. since 1915, Mr. Fisher had been Vice-President from 1935 to 1949, as well as Director of the Engineering and Research Depts. A member of many technical and scientific organizations, he was especially active in various phases of the work of the Society of Automotive Engineers, and during World War II served on the War Advisory Committee, Ordnance Dept. He represented his company in ASTM for many years.

S. Griswold Flagg, President, Stanley G. Flagg and Co., Inc., Stowe, Montgomery Co., Pa. (September 14, 1953). Representative of company membership since 1945.

Ernest E. Howard, Senior Partner, New York and Kansas City consulting firm of Howard, Needles, Tammen & Bergendoff, which specializes in bridge design, died suddenly in his office in Kansas City, Mo., on August 19, 1953. A graduate of the University of Texas in 1900, Mr. Howard had been in private practice since 1901—for most of the period as a partner in Howard, Needles, Tammen & Bergendoff and its predecessor organizations. His firm's recent projects included the New Jersey Turnpike and the Delaware Memorial Bridge at Wilmington. Mr. Howard himself was consultant to the Commission on Renovation of the White House. A member of a number of technical organizations, he was a Past-President of the American Society of Civil Engineers, having set a record during his Presidency in 1950 for travel to Local Section and Student Chapter Meetings. He had been affiliated with ASTM for the past 25 years.

Ben H. Hughes, President, Hughes Brothers, Inc., Seward, Nebr. (June 23, 1953). Member since 1950, and active in the work of Committee D-7 on Wood and its Subcommittee VII on Wood Poles and Cross Arms.

Raymond D. Lepley, Construction Engineer, Atlantic Refining Co., Philadelphia, Pa. (September 22, 1953). Representative of his company since 1938 on Committee A-1 on Steel, and its Subcommittees IX on Steel Tubing and Pipe, and XXII on Valves, Fittings, Pipings and Flanges for High-Temperature and Subatmospheric Temperatures.

(*Continued on page 64*)

Kodak reports to laboratories on:

our service to those who want to determine cadmium and other things... selecting photographic plates for electron micrography... a roundup of materials for color photography

Cadmium determination

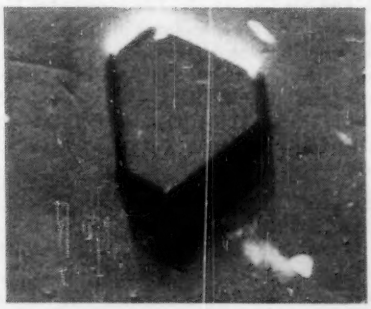
2-(o-Hydroxyphenyl)benzoxazole is a reagent very easily prepared in good yields. We say this on the authority of the two gentlemen who have found it to be more selective in the determination of macro amounts of cadmium than any other reagent mentioned in the literature. All they did to prepare it was to grind one mole each of o-aminophenol and salicylamide in a mortar until finely powdered, then heated in a round-bottomed flask immersed in an oil bath. The mixture melted at about 90 C, evolving ammonia and water. After one hour, they raised the temperature to 200 C and kept it there until no more ammonia came off. (Altogether it took about four hours of heating.) Then they transferred the melted mixture to a distilling flask and distilled under atmospheric pressure, obtaining a red mass. After recrystallization from ethyl alcohol three times, the job was done. There's no reason why anyone who wants to determine cadmium cannot prepare this reagent himself—except that, unlike the gentlemen who worked out the test, he has no reason to do so. It's much sounder economics to ask his purchasing agent to buy him some *Eastman 6754*.

As for the determination itself, we'll be happy to send you an abstract. As a matter of fact, we'll be happy to send you a 12-page list of our abstracts on the determination of a great many substances besides cadmium. Just write to Distillation Products Industries, Eastman Organic Chemicals Department, Rochester 3, N. Y. (Division of Eastman Kodak Company).

Electron microscope

From work we've done with step wedges in the electron microscope emerge some reasonably plain facts that may be helpful in selecting photographic plates for electron micrography. The wedges are made by successive gold-palladium shadowings of silver halide crystals with increasing obliquities, as pictured in the electron micrograph at right.

The archaic-sounding *Kodak Lantern Slide Plates* still seem to be the best all-around bet for recording what the ultra-modern electron microscope reveals. They're in-



expensive, they provide a wide range of sensitometric characteristics through choice of developer and development time, they're fine-grained, and we stock them in the usual sizes for the electron microscope. There are *Kodak Lantern Slide Plates, Medium* and *Kodak Lantern Slide Plates, Contrast*. We used to think that the latter gave slightly higher contrast in areas of low exposure, but we now must confess that whatever the differences between them to light exposure, to electron exposure they're pretty much alike. (The medium plate does have slightly finer grain.) The step-wedge project does, however, reveal some aces up our sleeve for the benefit of the electron micrographer with a special problem, viz.:

Kodak Spectroscopic Plates, Type III-O are much faster and have a more uniform density gradient over the exposure range, but have coarser grain than Kodak Lantern Slide Plates.

Kodak Spectroscopic Plates, Type IV-O are about three times as fast to electron exposure as Kodak Lantern Slide Plates and only slightly more grainy.

Kodak Spectroscopic Plates, Type V-O have a finer-grained but slower emulsion than Kodak Lantern Slide Plates.

Kodalith Ortho Plates, an all-or-none proposition we make principally for the photomechanical trades, should be resorted to by the electron micrographer only when in dire need of the highest attainable contrast.

Your Kodak Industrial Dealer handles all these plates. If you'd like a reprint of the paper that describes our step-wedge investigations, or if you need help in locating the right dealer, write Eastman Kodak Company, Industrial Photographic Sales Division, Rochester 4, N. Y.

Color

A color photograph speaks more eloquently than one in black-and-white. Here, then, is a rundown of the products we offer for imparting this eloquence and the additional informational capacity it adds to photography.

Kodachrome Film everybody knows about. Comes in 16mm and 8mm for movie cameras and 35mm for still cameras. "You press the button, we do the rest."

Kodacolor Film is for roll film cameras. We process to a negative without additional charge, and then from your Kodak dealer you order prints or enlargements. No projection, no holding up against the light.

Beyond these two that are familiar to millions of amateurs there is *Kodak Ektachrome Film*. It comes in roll and sheet film form, and you (or a local lab) convert it to a transparency. If you'd rather have a print to look *at*, we can make you a *Kodachrome Enlargement*, provided your original is 4″ x 5″ or less. If it's larger, we suggest a print by the *Kodak Dye Transfer Process*. This you can undertake yourself or leave to a commercial laboratory for a creation of smashing visual impact.

Finally, if you'll be wanting several duplicates at minimum cost, particularly of exhibition size and with the color brilliance so easily achieved in a transparency, make your original negative on *Kodak Ektacolor Film* and your duplicates on *Kodak Ektacolor Print Film*.

Your Kodak dealer sells all these items and also the Kodak Color Handbook *($4) that delves deeply into the details. Write Eastman Kodak Company, Rochester 4, N. Y., if you have any difficulty finding out what you want to know.*

This is one of a series of reports on the many products and services with which the Eastman Kodak Company and its divisions are ... *serving laboratories everywhere*

Kodak
TRADE-MARK

(*Continued from page 62*)

A. A. Klein, Assistant Director of Research, Norton Co., Worcester, Mass. (August 25, 1953). Representative of his company in ASTM since 1920, participating through the years in the activities of Committee B-8 on Electrodeposited Metallic Coatings and its Subcommittee IV on Electroplating Practice; also an important contributor to the work of Committee E-1 on Methods of Testing where he had been serving as Chairman of Subcommittee 10 on Sieves; and an active member of the ASTM New England District Council since 1947. Associated with the Norton Co. for 37 years, Mr. Klein was esteemed by his co-workers and those priviledged to serve with him on technical groups. In his passing the abrasive industry in general loses a competent scientist and an authority in the field of petrography, abrasives, and abrasive products.

Walter W. Pitann, Chairman and Founder, Precision Scientific Co., Chicago, Ill. (August 15, 1953). Member of ASA Sectional Committee Z 23 on Specifications for Sieves for Testing Purposes since 1931. Mr. Pitann had been very much interested in the activities of ASTM, and he supported the work of his company in making available much equipment required for carrying out ASTM tests in compliance with the specifications. His work was characterized by initiative and energy and brought him into contact with all of the leading distributors of laboratory supplies and testing equipment throughout the country.

(George) Martin Shepherd, Chemist, National Bureau of Standards, Washington, D. C. (suddenly, September 17, 1953). Serving as representative of the Bureau on ASTM Committee D-3 on Gaseous Fuels and its advisory group since 1935, Mr. Shepherd had been very active in a number of the subcommittees, directing the activities of Subcommittee VII on Complete Analysis of Chemical Composition of Gaseous Fuels for many years. In this capacity he was responsible for the preparation of several different standards on analysis of gaseous fuels. He will long be remembered for his accomplishments in this field. Through the years he made many outstanding contributions to the program of Committee D-3, and his loss will be felt keenly by his many friends and associates in the work of ASTM. He was a valued contributor also to the work of the American Gas Association. In ASTM he had rendered further service on Committee D-22 on Atmospheric Sampling and Analysis since the organization of this group in 1951.

Alfred Holmes White, Professor Emeritus of Chemical Engineering at the University of Michigan, Ann Arbor, died August 18, 1953, of a heart condition while at his office. Member of ASTM since 1909. A leader in the field of engineering education, and a Past-President of the American Society for Engineering Education, Dr. White was educated at McGill University, University of Michigan, and in Zurich, Switzerland. He was given an honorary Sc.D. by Northwestern University in 1942. He joined the faculty of the University of Michigan in 1897, becoming head of the Dept. of Chemical Engineering in 1914, and Chairman of the Dept. of Chemistry and Metallurgy in 1938. He was Consulting Engineer to the U. S. Bureau of Mines 1910–1920. He authored many papers dealing with manufacture and testing of illuminating gas, fixation of nitrogen, manufacture and properties of portland cement. He secured the first gas-industry-supported research fellowship in this country at the University of Michigan about 1900, and he and his students pioneered in the introduction of the science of chemical engineering to the manufacture of gas and coke from coal. In ASTM he was active through the years in the work of Committee D-5 on Coal and Coke. He also had served on Committee D-19 on Industrial Water. His book on "Engineering Materials," which has been widely used in educational work, incorporated a considerable amount of material from ASTM standards and other sources which he felt provided authoritative information for the students on subjects he was covering.

Bureau of Standards Notes . . .

Charles Beckett has been appointed Chief of the Thermodynamics Section. He will supervise experimental and theoretical programs of the section which include investigations of the thermal properties of materials containing fluorine, boron, or deuterium in addition to the more common substances such as air, carbon dioxide, and hydrocarbons. Associated with the Bureau since 1950, Dr. Beckett was formerly a research associate for the American Petroleum Institute at the University of California.

Harold O. Wyckoff has been appointed Chief of the Radiation Physics Laboratory. As Chief of the Laboratory, which comprises five sections, and Chief of the X-ray Section, he directs the research investigations of the laboratory and provides consultative services in radiation physics. The X-ray Section is concerned principally with X-ray protection, development of primary and secondary standards, and associated research in dosimetry including both X-rays and neutrons. Joining the Bureau staff in 1941, Dr. Wyckoff became Chief of the X-ray Section in 1945, and had been Assistant Chief of the Radiation Physics Laboratory since 1948. For the important part he played in the Eniwetok tests of atomic weapons by the Atomic Energy Commission he received the Department of Commerce Meritorious Award.

NEWS NOTES ON
Laboratory Supplies and Testing Equipment

CATALOGS AND LITERATURE

Internal Insulators for Electronic Tubes—An illustrated four-page folder has been released by American Lava Corp. describing the mechanical and electrical properties required in vacuum tube insulators. Lava and synthetic ceramics are discussed in relation to these requirements, as well as to necessary precision, design, and quantity. Bulletin No. 537 contains illustrations and features a property chart for the materials with ASTM Test Numbers indicated. Copy free on request.

American Lava Corp., Chattanooga 5, Tenn.

Strain Gages—A new domestic price list of SR-4 Strain Gages, Instruments, and Accessories is announced by Baldwin-Lima-Hamilton Corp. Specifications for 105 sizes and types of gages are tabulated. One page is devoted to considerations necessary in selecting SR-4 gages. Cements and waterproofing equipment are also included. Copies available on request.

Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

Article Reprint Request Sheet—Now available from Brookfield Engineering Labs., these sheets describe and classify by item number "Technical Papers on Viscosity Determination and Control." Reprints may be obtained of the 16 papers listed. Request copy by name from "Technical Service Dept."

Brookfield Engineering Labs., Inc., Stoughton, Mass.

Gas Analysis Apparatus—Burrell Catalog 81 lists and describes equipment and accessories for gas analysts. The 48-page book outlines methods, lists models and types of apparatus, and offers aid for their proper selection. A complete subject index is keyed to page numbers. Five pages cover laboratory models of gas analyzers while another ten pages describe portable types for on-the-job use as well as by laboratory technicians. Copies may be had on request.

Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

High Vacuum Applications—A new 60-page bulletin on High Vacuum Apparatus, now available, contains information, charts and other data. Subjects include the

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following: planning the High Vacuum System; connections and speed of evacuations; selection of High Vacuum Pumping Systems; low pressure technique; as well as illustrations and descriptions of various types of high vacuum pumps, oil diffusion pumps, vacuum gages, and vacuum accessories. A copy of Bulletin 10F may be obtained without charge.

Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Ill.

Instrument Topics—Recently announced by Consolidated Engineering Corp. is Vol. 7, No. 2, of "CEC Recordings." Bulletin CEC-1200-26 lists nine articles on modern instruments and instrumentation.

Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Dual-Beam Cathode-Ray Voltmeter—It has been announced by Allen B. Du Mont Labs. that a bulletin on the new Du Mont Type 322-A Cathode-Ray Oscillograph is now available. Du Mont Type 322-A is an improved, redesigned counterpart of Du Mont Type 322 Dual-Beam Cathode-Ray Oscillograph. The bulletin contains technical specifications, description, and photo-recordings made with the new instrument.

Allen B. Du Mont Labs., Inc., 760 Bloomfield Ave., Clifton, N. J.

How to Add Mobility to Your Laboratory—An illustrated booklet released by Fisher Scientific Co. describes the engineering and design features of the Fisher MOBILAB, a testing laboratory-on-wheels adapted for work in the field. It was stated that other applications to industry included the following: in public health work; as a rolling clinic; in forestry and agriculture; in the food processing industry.

Fisher Scientific Co. 717 Forbes St., Pittsburgh 19, Pa.

Miniature Multitester—A recent Data Sheet giving information on a Miniature Multitester combination volt-ohm meter for testing resistances and a-c or d-c voltages has been announced by International Instruments, Inc. This tester is small in size and designed for use in the field. It has four d-c voltage ranges reading to 300 v, four a-c voltage ranges reading to 600 v, and four resistance ranges reading to 2,000,000 ohms, all selected from the front with rotary switch. Write for free copy of Data Sheet.

International Instruments, Inc., P.O. Box 2954, New Haven 15, Conn.

Fan Scale Calculator—A four-page bulletin which contains information on the latest model JAco Fan Scale Calculator is now available from Jarrell-Ash Co. The calculator quickly and easily provides a continuous check on gamma and eliminates the need for actually plotting the emulsion characteristic curve. Results are read directly in terms of intensity ratio or logarithm of intensity ratio.

Jarrell-Ash Co., 26 Farwell St., Newtonville, Mass.

Miniature Ball Bearings—A new 20-page catalog offers the latest design and application data on miniature ball bearings. All technical data, printed in large type, are supported by drawings, graphs, tables, and photographs. Data include radial, angular contact, pivot, and thrust bearings.

Miniature Precision Bearings, Inc., Keene, N. H.

Unit Measuring Systems—Instrumentation Data Sheet No. 10.10-4 recently published by Minneapolis-Honeywell Regulator Co. contains information on the Gardner Automatic Photometric Unit, with reference to automatic measurement of color, gloss, and reflectance. All tests made in accordance with ASTM specifications. Topics deal with applicability, equipment required, optional equipment, operation, high-speed balancing motor, and easy adjustments.

Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Services Rendered—Foster D. Snell, Inc., attempts to solve the problem of selling consulting services in a new 22-page spiral-bound booklet available on request. The illustrated booklet entitled "Services" is a sort of Who, What, Where, and Why on the applied research, development, and testing offered by Snell. Copies are available from Public Relations Dept.

Foster D. Snell, Inc., 29 W. 15th St., New York 11, N. Y.

INSTRUMENT NOTES

Largest Testing Machine—An order for the largest universal testing machine ever built has been placed with Baldwin-Lima-Hamilton Corp. The new hydraulic machine has been ordered by Lehigh University for delivery not later than February, 1955. Although it will be the third testing machine of 5,000,000 lb capacity built by Baldwin for tests in tension, compression, and flexure, it will have greater height than either of the other machines.

Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

P-M Thermometer—A new thermometer has recently been introduced on which the lines and numbers will not disappear as a result of any chemical action. The P-M process induces a direct penetration of ions into the glass which colors the markings permanently. It may be used in solvents and acids which formerly required metal- or glass-enclosed thermometers. Available to ASTM specifications.

Brooklyn Thermometer Co., Springfield Gardens, N. Y.

New Flask Heaters for Laboratories—A new line of electric flask heaters for laboratories has been announced by Burrell Corp. Known as Forma-Heaters, they are designed for repeated use over long periods of time. Stock sizes are available for flask capacities from 500 to 5000 ml.

Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

Special Thermoseal Tinplate Scale—A scale has recently been introduced by John Chatillon & Sons for accurate weighing of large sheets of tin plate. The thickness of tin plate is measured by a comparison of the weight of steel sheets before and after plating. It was stated that conventional low capacity scales have too small a platform for these sheets, while scales with sufficiently large platforms have too high a capacity.

John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.

Miniature Oscillograph for Laboratory and Field—A new wide-band, quantitative oscillograph is announced by the Instrument Div. of Allen B. Du Mont Labs., Inc. The instrument, designated Du Mont Type 301-A, measures 9¼ by 6½ by 16⅝ in. and weighs only 20 lb. Circuits for precision calibration of both time and amplitude are incorporated. Further information available from Technical Sales Dept.

Allen B. Du Mont Labs., Inc., 760 Bloomfield Ave., Clifton, N. J.

New Laboratory Item—A new variable speed Universal Stirrer can be employed in many positions because of a double swivel clamp with an easy-operating hand wheel lock. Capable of handling a wide range of laboratory stirring jobs, this 1/50-hp stirrer, with speeds up to 5000 rpm, offers maximum torque at various speeds by employing two output shafts, one being driven through a gear reducer. Request Bulletin 480 for complete information.

Eberbach Corp., Ann Arbor, Mich.

Proximity Meter—Capacitance Gage—This unit provides a general utility instrument useful for comparing, measuring, or monitoring dimensions and distortions not possible by mechanical means. Other suggested applications include: as a concentricity gage, a micrometer, a dielectric comparator, a paint or insulation thickness gage, strain gage, or surface gage. Full details available on request.

Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Phila. 33, Pa.

New Micrographex Comparator—General Scientific Co. announces the development of equipment designed for grain size determination. The Micrographex Comparator provides a simple and accurate means for the determination of grain size in copper and copper base alloys. Positive identification of grain sizes from 0.010 to 0.200 mm as classified by the ASTM Method E 79[1] is quickly accomplished.

General Scientific Equipment Co., 3011 Dixwell Ave., Hamden 14, Conn.

Vacuum Gage—A modified unit, manufactured by Hastings Instrument Co., features a switching unit to monitor five positions in a vacuum system. The ability to make selective readings at any of five stations, it is said, will allow laboratories to establish permanent multiple point monitoring systems for measurements in the low micron range.

Hastings Instrument Co., Inc., Super Highway at Pine Ave., Hampton, Va.

Laboratory Pipet—Recently developed by the Kimble Glass Co. is a new flint glass pipet with a built-in constriction designed to facilitate use of the conventional cotton plug for the protection of both laboratory workers and the solutions and cultures with which they work. The cotton plug provides a safeguard for the laboratory worker pipetting solutions containing harmful bacteria. It also prevents contamination of solutions or cultures by bacteria from the breath of the operator. The new pipets are available

[1] Tentative Methods for Estimating the Average Grain Size of Wrought Copper and Copper-Base Alloys (E 79 - 49 T) 1952 Book of ASTM Standards, Part 2, p. 1144.

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NOW! A Machine Fast Enough for SHOCK Tests on Structures

Oscilloscope X-Y diagram system records stress-strain curves in shock testing

The extraordinary high speed of response of this revolutionary new Baldwin-Emery universal testing machine, paired with an oscilloscopic X-Y diagram, enables it to measure and record shock tests on complete structures. Its SR-4 load cells and SR-4 type extensometer make it capable of responding to the rates required by shock conditions.

The load cells and extensometer feed signals to the oscilloscope through pre-amplifier circuits. An instantaneous stress-strain curve and its two axes then appear on the oscilloscope screen. It is possible to have this screen photographed continually to record changes in the shape of the stress-strain curve as the structure itself changes.

Its unique aptness for such shock tests is one of the reasons why the FGT SR-4 Testing Machine is being recognized as *the greatest advance in materials testing equipment in twenty years.*

Full details on this latest contribution of Testing Headquarters are in Bulletin 4202. For your copy, write to Dept. 2203, Baldwin-Lima-Hamilton Corporation, Philadelphia 42, Pa.

TESTING HEADQUARTERS

BALDWIN-LIMA-HAMILTON

General Offices: Philadelphia 42, Pa. • Offices in Principal Cities

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in two sizes, 5 and 10 ml, both of 350 mm length.

Kimble Glass Co., Subsidiary of Owens-Illinois Glass Co., Toledo 1, Ohio.

Blacklight Wand—Menlo Research Lab. has developed a compact new "Blacklight Wand" model for immediate addition to its series of "Fluoretor" portable ultraviolet instruments. Field tests indicate the new Wand will broaden use of ultraviolet detection and comparison. It is stated that the factors of ready portability and independence of normal power outlets make the "Blacklight Wand" particularly useful in field work such as mining, prospecting, petroleum geology, and materials testing. Descriptive literature available on request.

Menlo Research Lab., P.O. Box 522, Menlo Park, Calif.

Scintillation Counters—Two new scintillation counters have been presented by The Radiac Co., Inc. The "Fission Finder" Scintillation Survey Meter and the "Fission Tackle" Scintillation Drill Hole Probe-Type Radioactivity Detector are self-contained battery-operated scintillation counters for detecting and measuring radioactivity. These instruments are gamma sensitive, and are approximately 100 times more sensitive than the average Geiger counter. The "Fission Finder" Survey Meter can be made to detect alpha and beta activity when used with the appropriate phosphore.

The Radiac Co., Inc., 489 Fifth Ave., New York 17, N. Y.

Hot Plate—A new model announced by Thermo Electric Mfg. Co. has been designed for laboratory and industrial use. The equipment provides precise thermostatic control from room temperature to 270 C. Surface plate temperature varies less than 3 deg at any point over the full heating range.

Thermo Electric Mfg. Co., Dubuque, Iowa.

Electronic Thermometer—A new remote reading electronic thermometer manufactured by The Yellow Springs Instrument Co. has recently been announced. The "Tele-Thermometer" operates in the range from 68 to 105 F, with temperature read direct from a large dial calibrated in both Centigrade and Fahrenheit. Temperature fluctuations can now be held under constant observation from a remote position, without visual error or need to manipulate controls. The instrument consists of a thermistor which, because it changes greatly in electrical resistance with small temperature changes, can be placed in a calibrated circuit that translates and indicates flow of current through the thermistor as a temperature reading.

The Yellow Springs Instrument Co., Yellow Springs, Ohio.

INSTRUMENT COMPANY NEWS

Beckman Instruments, Inc., South Pasadena, Calif.—Robert T. Jones, former sales executive with Applied Research Labs., recently joined Beckman Instruments, Inc., where he will head export sales. During a five-year tenure with ARL he held administrative posts in virtually all phases of the operation, from production to foreign and domestic sales.

Fisher Scientific Co., Pittsburgh, Pa.—J. S. Fawcett has been named director of the Fisher Scientific Co. Development Labs. according to a recent announcement. Mr. Fawcett joined Fisher Scientific in 1951, and for the past two years has headed the Fisher-TAG Div., directing the redesign of the entire line of Tagliabue oil-testing instruments purchased by the company.

Hatch Textile Research, Inc., New York, N. Y.—Herbert H. Hatch, president of this testing laboratory, marked his 45th anniversary in the textile business in September. He is a member of the American Society for Testing Materials, Textile Research Institute, American Assn. of Textile Chemists and Colorists, and Charter member of American Assn. of Textile Technologists. Mr. Hatch has been concerned principally with examinations and testing of fabrics, yarns, and fibers.

Thomas A. Edison, Inc., West Orange, N. J.—Promotion of George J. Bindewald to general sales manager of the Edison Instrument Div. was recently announced by Thomas A. Edison, Inc. He joined the Edison Instrument Div. in 1946 as a sales engineer and in 1951 was advanced to aeronautical sales and service manager. Mr. Bindewald now has the added responsibility for selling and servicing all products of the Division and coordinating the activities of their manufacturer's representatives in the general industrial field.

Nuclear Instrument and Chemical Corp., Chicago, Ill.—Dr. E. B. Tilton has been elected chairman of the board and chief executive officer of the Nuclear Instrument and Chemical Corp. according to a recent company announcement.

Precision Scientific Co., Chicago, Ill.—Election of Chester A. Warner as chairman of the board and John J. Kinsella to the presidency to succeed Mr. Warner was announced recently by Precision Scientific Co. Arthur Pitann becomes vice-president and secretary to fill the position vacated by Mr. Kinsella. The Board appointed George E. Bader and Edmund E. Tice vice-president in charge of manufacturing and vice-president in charge of finances, respectively.

LABORATORY NEWS

Arthur D. Little, Inc., Cambridge, Mass.—Earl P. Stevenson, president, has announced that the employees' trust of Arthur D. Little, Inc. recently acquired controlling interest in the company, the largest industrial research organization of its kind. The change was brought about by an offer from the employees' retirement trust to purchase the shares of common stock of individual holders. Among these were the shares held in trust for the benefit of the Massachusetts Institute of Technology. Mr. Stevenson said that there will be no change in the company's management or methods of operation. This organization employing over 700 people conducts consulting research, engineering, and related activities in virtually all fields of applied science.

Jarrell-Ash Co., Newtonville, Mass.—The home office of this company is now located at 26 Farwell St., Newtonville, Mass. The new quarters include the analytical laboratory, completely equipped with spectrographic and x-ray equipment, a greatly expanded research department, and increased sales and service facilities.